REPORT RESUMES

ED 010 880
AL 000 102

THE PSYCHOBIOLOGICAL INVESTIGATION OF THE DEVELOPMENT OF NEW VERBAL BEHAVIOR. FINAL TECHNICAL REPORT.

BY- FERSTER, C.B.

INSTITUTE FOR BEHAVIORAL RES., SILVER SPRING, MD.

PUB DATE JUL 66

EDRS PRICE MF-$0.18 HC-$3.72 93P.

DESCRIPTORS- *PROGRAMED INSTRUCTION, LANGUAGE INSTRUCTION, MOTIVATION, *TEACHING MACHINES, REINFORCEMENT, RESEARCH, *PSYCHOLINGUISTICS, *GERMAN, *VIETNAMESE, SILVER SPRINGS

THESE EXPERIMENTS WITH VERBAL BEHAVIOR WERE CARRIED OUT AS AN EXTENSION AND ADAPTATION OF GENERAL LABORATORY PRINCIPLES DEVELOPED WITH ANIMALS. THE EXPERIMENTS COVERED THREE AREAS. THE FIRST WAS AN APPLICATION OF GENERAL PRINCIPLES OF VERBAL BEHAVIOR, LARGELY BASED ON SKINNER'S ANALYSIS, TO THE PROBLEMS OF TEACHING A SECOND LANGUAGE. ACTUAL TEACHING PROGRAMS WERE DEVELOPED IN GERMAN AND VIETNAMESE. THE SECOND AREA OF RESEARCH WAS A PROGRAM OF EXPERIMENTS DESIGNED TO TEST THE HYPOTHESIS THAT TRAINING AS A LISTENER AND A READER WOULD ENHANCE THE DEVELOPMENT OF SPEAKING AND WRITING. THE EXPERIMENTS WERE CARRIED OUT, USING A SINGLE VIETNAMESE PHONEME, TO TRACE THE INFLUENCE ON PRONUNCIATION OF THE SUBJECT'S SKILL AS A LISTENER. A THIRD AREA OF EXPERIMENTS CONCERNED MOTIVATIONAL VARIABLES. THE AUTOMATIC PROGRAMING OF THE TEACHING MACHINE MATERIALS MADE IT POSSIBLE TO MANIPULATE MANY OF THE RELEVANT REINFORCERS. THE EXPERIMENTS DEALT MAINLY WITH THE ASPECT OF THE TEACHING MACHINE PERFORMANCES THAT WERE REINFORCED. THIS DOCUMENT IS ALSO AVAILABLE FROM THE CLEARINGHOUSE FOR FEDERAL AND SCIENTIFIC AND TECHNICAL INFORMATION, SPRINGFIELD, VIRGINIA 22151, AND FOR QUALIFIED INVESTIGATORS, FROM DDC, CAMERON STATION, ALEXANDRIA, VIRGINIA 22314. (RS)

AL 000 102

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ED010880

Final Technical Report

March 1, 1960 -- March 1, 1966

C. B. Ferster

Institute for Behavioral Research, Inc.
2426 Linden Lane, Silver Spring, Md. 20910

THE PSYCHOBIOLOGICAL INVESTIGATION OF THE DEVELOPMENT OF NEW VERBAL BEHAVIOR

DA 49-193-MD-2577

Qualified investigators may obtain
copies of this report
from the DDC

Part I, An Experiment in Teaching a Second Language, was carried out in collaboration with M. I. Rocha e Silva.

Parts II and III, Experiments on echoic behavior and motivational variables, were carried out in collaboration with James Sherman, Ph.D.

AL 000 102

ABSTRACT

1. Preparing Institution: Institute for Behavioral Research, Inc.

2. Title of Report: The Psychobiological Investigation of the Development of New Verbal Behavior

3. Principal Investigator: C. B. Ferster

4. Number of pages, illustrations and date: 79; Figures 1-4; Tables 1-3; July 8, 1966

5. Contract Number: DA 49-193-MD-2577

6. Supported by: U. S. Army Medical Research and Development Command
Department of the Army
Washington 25, D. C.

Experiments were carried out with verbal behavior which are extensions and adaptations of general laboratory principles developed with animals. The experiments have been in three areas. The first was an application of general principles of verbal behavior, largely based on Skinner's analysis of verbal behavior, to the problems of teaching a second language. Actual teaching programs were developed in German and Vietnamese.

The second area of research was a program of experiments designed to test the hypothesis that training as a listener and a reader would enhance the development of speaking and writing. The experiments were carried out, using a single Vietnamese phoneme, to trace the influence on pronunciation of the subject's skill as a listener. A third class of experiments concerned motivational variables. The automatic programming of the teaching machine materials made it possible to manipulate many of the relevant reinforcers. The experiments dealt particularly with the aspect of the teaching machine performances that was reinforced. In some experiments reinforcement occurred at the end of the session when the student demonstrated the new performance in the second language. In other experiments the reinforcement occurred card by card as the student went through the program, etc

7. Key Words:
Teachine machine, Second language instruction, Matching-to-sample, Programmed instruction, Schedules of reinforcement.

NOTE: Copies of this report are filed with the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314 and may be obtained from that agency by qualified investigators working under Government contract.

The Psychobiological Investigation of the Development of New Verbal Behavior

Experiments were carried out with verbal behavior which are extensions and adaptations of general laboratory principles developed with animals. The experiments have been in three areas.

Second Language Teaching Programs

The first was an application of general principles of verbal behavior largely based upon Skinner's analyses of verbal behavior to the problems of teaching a second language. The teaching program, previously developed by the principal investigator in the German language, was refined and extended. A field trial was carried out in German using college students. The results of this experiment are reported in the article attached entitled, "An Experiment in Teaching a Second Language." This article describes the techniques of instruction embodied in the program and the general principles which were applied. The article is in press in IRAL. A teaching program in Vietnamese was also developed and tested. The Vietnamese program was designed as a tool for the study of the general motivational variables involved in learning the languages and hence was not so developed as the German. The Vietnamese program, however, showed the possibility of extending the general plan of the German materials to other languages, even as disparate as Vietnamese.

The Speaker and Listener in the Same Skin

The second area was a program of experiments designed to test the hypothesis that training as a listener and a reader would enhance the development of speaking and writing. We reasoned that if the student became a skilled listener under the control of fine details in nuance of the spoken and written language the effects of his speech on himself would differentially reinforce his own vocal productions. We, therefore, carried out a series of experiments with a restricted sample of Vietnamese sounds. The student was trained to listen to the sound and differential reinforcement was applied in terms of his ability to distinguish between appropriate and inappropriate designation of the Vietnamese phoneme. His pronunciation, however, was never corrected. As we tested his ability to pronounce the phoneme periodically as he underwent training as a listener we could measure the extent to which his training in listening and reading provided the appropriate differential reinforcement for speaking and writing.

Schedules of Reinforcement and Other Motivational Variables

A third class of experiments concerned motivational variables. The automatic programming of the teaching machine materials made it possible to manipulate many of the relevant reinforcers explicitly. For example, there is a hierarchy of reinforcers beginning with the tone which occurs when the student pushes the correct button. Then there is a coin, a counter indication or a spoken delivery which can occur every so many times the student completes a card correctly. For example, the student is paid 25 cents for each counter indication, and the counter advances one for each 15 successively correct cards which the student completes. Then following the lesson the student may interact with the instructor in such a way that he is given an opportunity to exhibit the new behaviors he has acquired in the preceding lesson. This interaction differentially reinforces the preceding behavior to the extent that the student finds progress in the language rewarding. Further contingencies were arranged by paying the student in terms of his progress rather than by the card. Under this condition instead of receiving so many cents for a certain number of successfully completed items the student is paid when he exhibits the required repertoire to the instructor. An additional variable in these areas is the actual schedules of reinforcement which because of the machine operation and explicit design of the procedures can be manipulated much as in the classical animal experiment.

I.

Programmed Instruction in German and Vietnamese

German

The following article in press in the International Review of Applied Linguistics in language teaching (IRAL) describes the rationale, method of use, and general content of instructional program in German.

An Experiment in Teaching a Second Language [1, 2]

M.I. Rocha e Silva and C.B. Ferster [3]

Institute for Behavioral Research

INTRODUCTION

This paper describes a semi-automatic method of teaching a rapid introduction to the basic structure of German derived from an operant conditioning analysis of verbal behavior. The predominant procedure is matching to sample (Ferster, 1963; Ferster, 1964). The program is presented to the student on 5 x 8 cards, the top part of which consists of a picture or a text. The student selects one of four texts or pictures from the lower part of the card. Reinforcement occurs when the student pushes the button under the text or picture which corresponds verbally or thematically to the sample. For example, in the simplest type of card, when the student hears the German "Buch", reinforcement occurs if he pushes the button under the picture of a book rather than the button under the picture of a chair or a boy; or a picture of a book in the center of the card might be the occasion on which he chooses the text "Buch" rather than the text for chair or boy. Sometimes the upper part of the card presents a picture and a text, a picture and an auditory stimulus, or a text and an auditory stimulus. The student hears "Where is the book?" and with the picture of a boy sitting on a chair and a book under the chair he pushes the button for the text "under the chair" rather than for "on the chair."

The matching-to-sample procedure requires the student to perform as a listener and a reader rather than as a speaker and a writer. Yet the goal of the program was to speak and write. We tested the hypothesis that an extensive repertoire as a listener and reader would provide the basic performance from which speaking and writing could emerge. We reasoned that once the student could respond meaningfully and in fine detail to the spoken and written language, he had an internal model which could serve as the instant and immediate reinforcement for his speaking and writing (Skinner, 1957). The process is substantially the same as that used to teach phonetics (Smalley, 1961) and similar to the way a child initially acquires verbal behavior. He becomes an accomplished listener (no, yes, breakfast is ready, breakfast is not ready, etc.) long before he is a speaker because his behavior on these occasions is reinforced or not, depending on what he hears.

The student's inaccuracies of articulation or intonation were not corrected at any point in the instructional program. We looked for improvement in pronunciation paced with the student's ability as a listener. The student began with English articulation patterns and we looked for their continuous shaping and redistribution. The more competent a listener the student became, the more he could react to his own behavior differentially in the direction of the standard forms of the second language.

The teaching program was designed primarily as an experiment and was not intended to be responsible for the student's entire language experience. For experimental purposes we restricted the student's experience to the automatic instructional program so that we could evaluate how much of an active repertoire in the language the matching-to-sample procedure, alone, could develop. If we had total responsibility for the student's second language instruction, we could, of course, supplement the teaching machine experience with other methods.

The program assumed that the student already had a highly-developed verbal repertoire in English, read the Roman alphabet fluently, and had pronunciation patterns at least roughly congruent with those of German. While we expected English structures and usages to interfere with those required in German, we minimized the interference by teaching German without translation. The only time the student heard English was at the start of the course when, for example, he had to be instructed in the use of the teaching machine or the rules for the teacher-student interaction. Most of the instructional procedures could be carried out automatically by relays and other automatic control equipment since the student's point of contact with the program occurred when he pushed a button.

METHOD

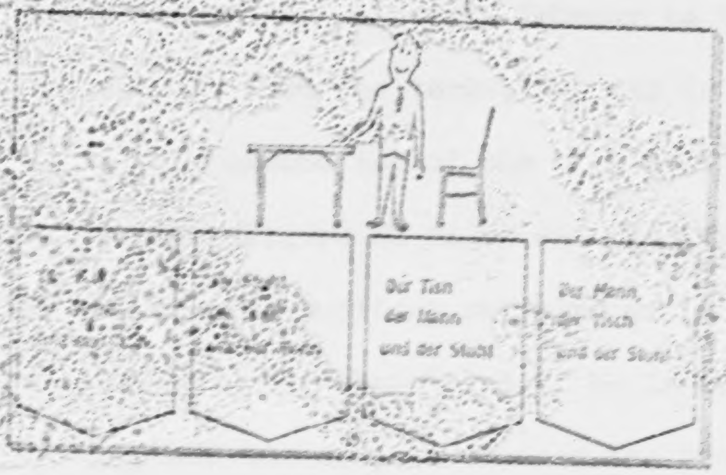
The Teaching Machine[4]

Figure 1 is a photograph of the teaching machine into which the student inserts a 5 x 8 card manually. The top part of the card contains the sample stimulus which in this card is a picture. Below each of the four boxes on the bottom part of the card is a button. (The student is instructed to press the button under the stimulus that corresponds to the picture or text in the center of the card.) The light on the face of the machine (a reinforcement for pressing the correct button) comes on automatically because a piece of conducting foil is pasted behind the card in the position of the correct stimulus. This aluminum foil shorts one of the four pairs of contacts in the machine so that appropriate reinforcement or nonreinforcement occurs, depending on which button the student presses. On cards where the student listens to the spoken language, the right-hand corner of the card is cut away exposing a button underneath, as in Figure 2D. The tape recorder runs while this button is held down. The student learns to press this until he hears the card number (in the new language) and the stimulus material. Two sharp clicks indicate the end of the stimulus where the student is instructed to release the button before the material for the next stimulus plays.

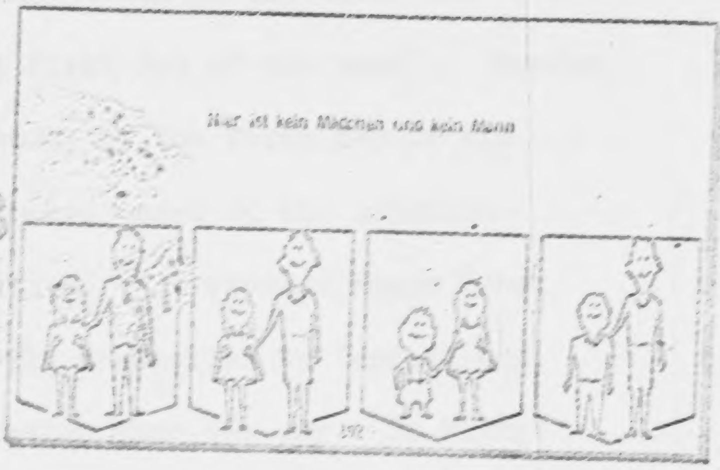
Sample Frames

Figure 2 shows the kinds of verbal arrangements that were programmed with the cards. In Figure 2A the stimulus is a picture (or picture and a text) and the student chooses one of the four texts below that corresponds thematically with the picture. In Figure 2B the sample is a text and the student chooses a picture thematically relevant to the text. In Figure 2C the sample is a text and the student chooses the text below that corresponds intraverbally to the sample text. Figure 2D is an example of a response controlled by an auditory stimulus. Note that the right-hand part of the card is cut away exposing the button underneath; when the student presses the button he hears, "Where is the nose?". Reinforcement occurs if the student chooses the text, "The nose is in the middle of the face." In some cases, the student simply has to pick out a text which corresponds, point-to-point with the auditory stimulus.

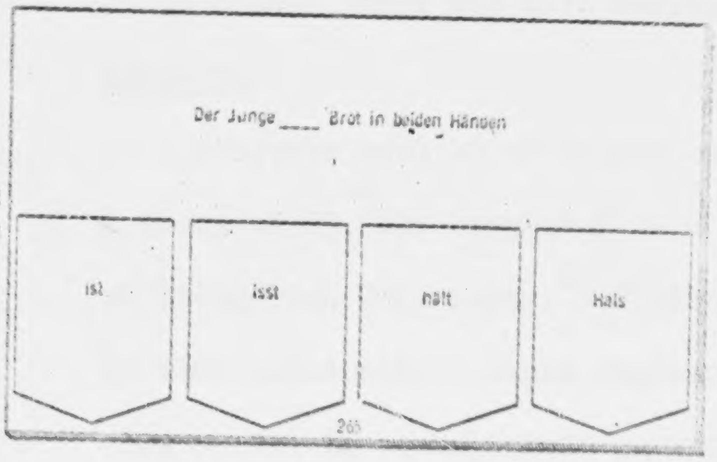
A


Der Tisch
der Mann
und der Stuhl
Der Mann,
der Tisch
und der Stuhl

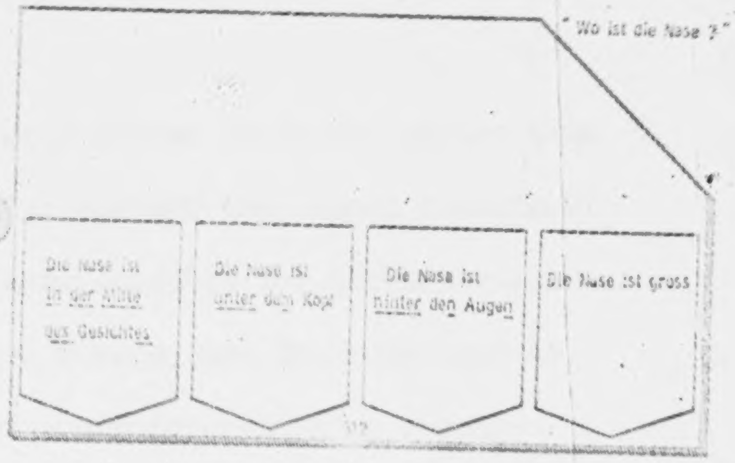
B


Hier ist kein Mädchen und kein Mann
392

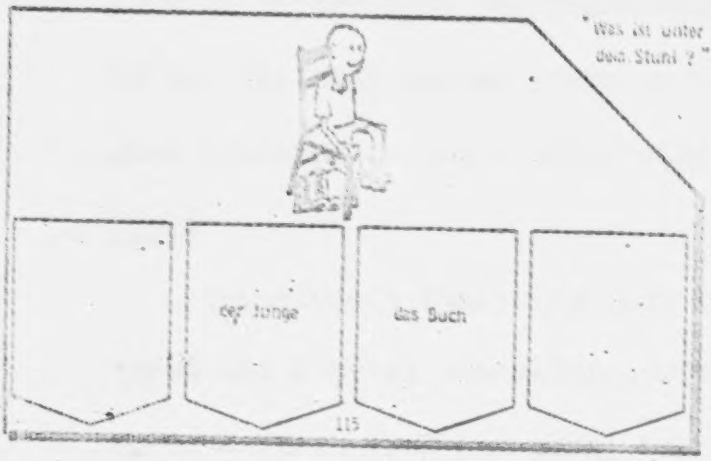
C


Der Junge ____ Brot in beiden Händen
ist
isst
hält
Hals
266

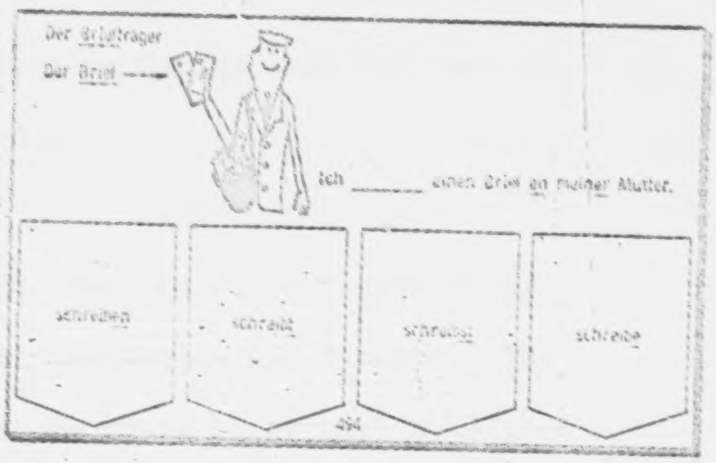
D


" Wo ist die Nase ? "
Die Nase ist in der Mitte des Gesichtes
Die Nase ist unter dem Kopf
Die Nase ist hinter den Augen
Die Nase ist gross

E


"Was ist unter dem Stuhl ? "
der Junge
das Buch
115

F


Der Briefträger
Der Brief
Ich ______ einen Brief an meiner Mutter.
schreiben
schreibt
schreibst
schreibe
494

For example, he hears, "Monday is the first day of the week" and chooses from the texts, "Monday is the first day of the week", "Monday is the second day of the week" or "Tuesday is the first day of the week." Figure 2E is an example of a choice based on the relation between an auditory stimulus and a picture. The student hears "What is under the chair" and if he is properly controlled by "under" (as opposed to "on") he chooses the book rather than the boy. In Figure 2F is a card where the verb ending is the critical stimulus.

Subjects

Subjects were 10 volunteer college freshman students, chosen from a group of 29, who responded to a notice through the German department at Georgetown University.[3] Students were accepted for the experiment if they could attend class regularly on Tuesday and Thursday, and if they wanted to learn German because of their interest in a foreign service career with the State Department. Their ages ranged between 17 and 19; they had no previous training in German, and all were in good standing in their university studies.

Probe

Immediately following each lesson that the student completed, there was a brief interaction with the teacher called a probe. The probe differs from the usual test because it is an attempt at direct measurement of the student's performance rather than a sample of behavior designed to allow us to infer the state of the total repertoire. The probe begins by asking the student to speak in German, as much as he can, along the lines of the material in the preceding lesson. Then the student is shown some of the pictures from the lesson and finally he is prompted either textually or vocally. Thus the probe is designed to exhaust the student's repertoire at all levels from free speech at the start of the probe to a highly determined response at the end such as "yes" in response to the question "Is that a man?". The probe was carried out entirely in German. Examples of performances in between free speech and a highly determined response such as "yes" or "no", are nonverbal responses such as sitting down in response to a request, or pointing to one of several objects in response to "Which one is a ______?".

The answer to the question of "How much behavior in the German language does the student have?" needs to be answered by specifying the degree of determination of the student's verbal response by thematic, textual, intraverbal or echoic stimuli. The probe was designed to give us a measurement of the performances generated by the instructional procedure. We could thus have a criterion for whether the student is to go on to the next section, engage in a remedial exercise or repeat the previous section. In most cases the discrepancy between the student's repertoire and our criterion of mastery was sufficiently small so that a few minutes of tutorial during the probe was sufficient to correct any deficiencies. We judged that it was essential that the student achieve perfect mastery of the materials at each stage so that his performance would not be disrupted by a cumulative deficit. The probe also served as a reinforcer for the student's study behavior since it exposed in clear form his accomplishment as a result of the lesson.

The probe emphasized the behaviors developed in the immediately preceding part of the program, so as to give immediate evidence of progress. Thus the probe was a contingency designed to make progress in the new repertoire a reinforcer.

Though one of the purposes of the probe was to demonstrate to the student, in a form slightly different from the exact form required during the teaching program itself, that his repertoire in German had in fact been substantially augmented, it also provided differential reinforcement in favor of those performances most effective with a fluent listener. The probe also provided direct interpersonal reinforcement for the student's speaking since the student actually altered the verbal behavior of his teacher in the new language and vice versa. Since the reinforcements during the automatic phase of the program are for reading and listening, the probe was also designed to develop the analogous active behaviors, speaking and writing. By requiring the student to write and speak during the probes, we intended to alter the student's conduct during the automatic phase of the program, in the direction of learning how to convert himself from a listener to a speaker, and from a reader to a writer. In this objective, we could depend upon the transcriptive repertoires already effective in the student's first language where, for example, he could say "chair" after hearing "chair", or write "chair" after reading "chair." To facilitate the development of an active repertoire the student was told to speak aloud everything he read in German.

The instructor never corrected the student's pronunciation or usage during the probe since we wished to find out how much active use of the language could be developed by training procedures in which the student is a listener and reader. Students frequently corrected their own errors, however, when the instructor paused after incorrect responses.

Like the intermediate probes the student's achievement at the end of the program was determined by direct measurement of his entire second language repertoire rather than by a test. The student was progressively prompted to get him to engage in all of the German he was capable of under all conditions. The following instructions guided the student during the written part of the final probe.

1. Write a few sentences of any of the themes given during the program.
2. Write some sentences on any other theme you remember.
3. From the list of themes which was given in the program, write a few sentences about those themes about which you have not yet written.
4. Go through the set of pictures which have been used in the frame cards and write sentences about these pictures.
5. Write the story of the Three Little Bears (on the assumption that the student can tell the story in English).
6. Make up a short story.
7. Go through the word list which you have learned in the program and write some sentences with the words which have not yet been used.

There was then some conversation with the student to record his verbal fluency with samples of the same usage. Tape recordings were made for purposes of measuring pronunciation accuracy. The recordings were made both as a student read a text and as he conversed with the experimenter.

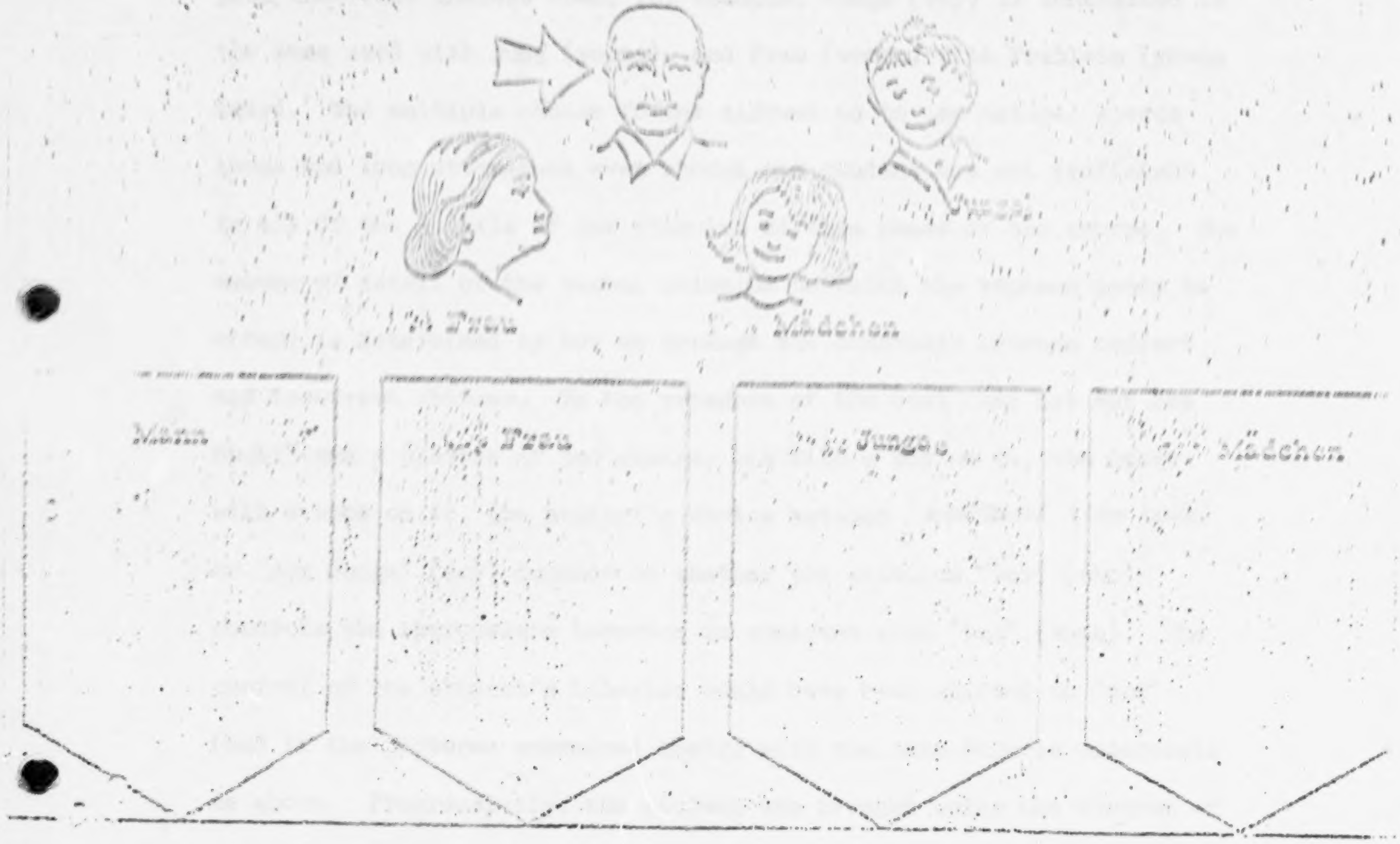
General procedure

In the first session the subject was taught how to use the machine, the format of the teaching program, and he read aloud from a text (taken from the program) so we would have a record of his reading pronunciation. Sessions were carried out twice a week, each session lasting approximately 3/4 of an hour, depending upon how rapidly the student worked. The first author was present continuously and observed all of the procedures. The probe, the oral interaction with the instructor, took place whenever a student completed a lesson. If a student did not complete a lesson within the allotted time, the probe was postponed to the next meeting after he had completed the unit.

THE DESIGN OF THE PROGRAM

Major programming principle

The major programming principle is that of differentially reinforcing the student's behavior (pushing one of the four buttons under the four choices). By such differential reinforcement, textual and auditory stimuli "in German" control the student's appropriate nonverbal or verbal action as he chooses from the four texts or pictures below. The general principle is to bring the student's behavior (choosing a text or picture) under the control of progressively finer details of German texts and utterances. In general we begin with a strongly determined response, and then withdraw, one at a time, the sources of control of the behavior, until the student can react to the language in a full natural context. For example, in the very first card, a picture of a boy, girl and woman are labeled appropriately in German, but the man is indicated only by an arrow.



The four stimuli below are the four texts corresponding to the pictures. The student picks "Mann" because the other texts can be matched with the inappropriate pictures. The card was designed to get the student to [illegible] the three texts in respect to the pictures until the response to "Mann" is strong in relation to the choice of the other three texts. On later cards, fewer variables determine the student's response to these texts. For example, in the second card the pictures are no longer labeled, so that the correct choice can no longer be made by matching the choices to the labeled pictures to find the text for the unlabeled figure. Later in the program, there will be a larger inclination to pick incorrect choices when, for example, Junge (boy) is contrasted in the same card with jung (young), and Frau (woman) with Fräulein (young lady). The multiple choice format allowed us to use natural speech forms and long utterances even though the student was not proficient in all of the details of the stimulus at this phase of the course. The amount of detail of the verbal stimulus to which the student needs to attend is determined by how we arrange the contrasts between correct and incorrect choices. In the presence of the text "wer ist auf dem Stuhl" and a picture of two chairs, one with a boy on it, the other with a book on it, the student's choice between "das Buch" (the book) or "der Junge" (boy) depends on whether the stimulus "wer" (who) controls the appropriate behavior in contrast with "was" (what). The control of the student's behavior could have been shifted to "auf" (on) if the pictures contained chairs with the same objects underneath as above. Progressively, the student was brought under the control of one part of the sentence at a time. It is not until a much later part of the program that the student is required to distinguish between forms of the article in order to make a correct response. At this stage of the program, the article "der" was not critical since the student was not confronted with a situation where he had to choose between die and der. Later in the program, of course, his reinforcement will depend on such a contrast.

The program underwent successive empirical tests, with one or two subjects at a time, and was revised each time until the error rate fell to about 3%. The revisions generally involved making it easier for the student to choose the correct alternatives using incorrect alternatives which are already well established in the student's repertoire and which control responses incompatible with the correct choice. For example, consider an auditory stimulus, "Where is the book" in conjunction with a picture of a chair on which a boy is sitting and under which is a book. The choice of "on the chair" versus "under the chair" is not very strongly determined as compared with another card in which the auditory stimulus is "who is on the chair." In a next card the choice of "boy" versus "book" is controlled by two stimuli, "who" and "on" either of which, in contrast with "what" and "under", can control a correct choice. This type of card has been illustrated in figure 2F. One type of card teaches the student to listen to an auditory stimulus simply by choosing one of four texts which corresponds, point to point to what the student hears. Depending on how close the "wrong" texts are to the correct one, the student comes under closer control of the auditory stimulus. For example, the student might hear "vier" (pronounced approximately like the English "fear") and selects the text "vier" from "Tür." In this case both the initial "f" sound as well as the Umlaut sound can control the student's response. The student becomes a more careful listener, however, when he must choose between the texts "vier" and "für."

The construction of concepts

Concepts and general classes of usage were developed inductively.

First we made sure all of the performances, other than the concept, were firmly in the student's repertoire. To bring the student's behavior appropriately under the control of "on, over, under, next to, in front of, behind" we began with a reliable repertoire controlled by the text picture and auditory "book, boy, girl, man, chair, table", etc. A series of pictures defined the spacial relation among the objects (the book is next to the chair, the boy is on it, and the chair is next to the table. A cup is on the table and a dog is under the table). A series of cards then requires the student to choose a text thematically appropriate to the picture. The student reads "What is on the table?" and he chooses from "dog, book and cup". He reads "What is under the table?" and chooses from the same texts. The meaning of the preposition comes from the circumstances under which it is reinforced. A series of questions of the form "Where is the bird?", "Where is the boy?", "Who is on the chair?", "What is next to the chair?" amplified the control of the student's behavior by these prepositions (amplified the meaning).

Grammatical usage, such as the use of the dative or the accusative following identical prepositions (auf, neben, unter, in) was developed in the same way. The concept was developed inductively by differentially reinforcing the student's response, depending upon whether the context of the sentence is transitive or intransitive. Here again the student was capable of all the distinctions required of him except the ending of the definite article. All that is required is that he distinguish between the case of the article depending on the context of the sentence. In actual practice, the student is given a large number of sentences such as "Der Junge ist in _____ Zimmer" or "Der Junge geht in _____ Zimmer." When the usage is intransitive the dative form of the article, dem, is reinforced; when it is transitive the accusative form, das, is reinforced. As before, the meaning or the concept comes from the differential reinforcement contingencies. The student comes to behave in terms of the rule whether or not he can state it formally. The student's repertoire is developed by the grammatical rule "that the accusative case is used with transitive verbs and the dative case with intransitive verbs." Although it might be useful to the student to pronounce the rule after he can perform appropriately to it, he can still use the cases meaningfully and accurately, even without being able to state the principle.

The same kind of inductive development of classes of verbal control was carried out with texts without using pictures. For example, the text at the top of the card might be "Are the dishes on the table?", "Are the dishes under the table?", or "Are the dishes over the table?". The student chooses from "on the table, under the table or over the table." In developing control by "who" and "what" the text at the top of the card is "Tom is in the house, Fred is in the forest. There is a small plant in the house but large plants in the forest." Successive cards would then have the questions (1) Who is in the house? (2) Who is in the forest? (3) What is in the forest? (4) What is in the house? In each of the four cards, the student chooses between Tom, Fred, a small plant, a large plant.

Pronunciation

Because we wanted to test the hypothesis that we could achieve progress in pronunciation primarily by training the student as a listener we avoided direct reinforcement and punishment of the student's speech. We presumed that the student will almost automatically differentially reinforce and shape his own behavior as he hears differences between his own speech and the speech of the native speaker so long as he is an effective listener who can react to nuances of the native speaker's speech. Theoretically, the process we are trying to simulate is the same as that in which a pre-verbal child copies the articulation and intonational patterns of those he admires.

Once the student can react meaningfully to the details of the utterances of the native speaker he has, in a sense, an "internal model" of parts of his language. Since he is his own listener as well as a speaker, the perception of the speech sounds of others already in his repertoire because of his past experience can serve as a differential reinforcer for successively approximating his own ability to speak. The most effective reinforcers would be those which differentially reinforce and successively approximate the tongue, larynx, and mouth patterns necessary for communicable speech. Even though the ultimate reinforcer that will maintain the student's speech is the change it produces on the behavior of a listener, it is only the instant and immediate consequences of speaking which are a precise enough contingency to differentially reinforce the subtle nuances of articulation, rhythm, and intonation. The effectiveness of the program, therefore, would depend upon whether the student talks enough to himself, aloud, so as to provide enough occasions to differentially reinforce his speech.

Use of textual stimuli

The overall rate of speech, and the length of an utterance, were kept as slow and short as possible, consonant with normal rhythm and intonation. As the student came under better control of the language he heard faster speech and longer utterances. We used many texts, early in the program, despite the likelihood that the student's pronunciation would be more likely to be controlled by his native language than by the new one. The text has the advantage that the student can quickly, easily and repeatedly produce the corresponding auditory stimulus. If a response is weak, repeated exposure to the stimulus may lead to the appropriate behavior when one instance would not. The auditory stimulus, in contrast to a text, is transient. Second, the student will sooner or later have to speak with the articulation and intonation of the second language while he reads from textual stimuli of the same orthography that controlled his behavior in the first language. Eventually the texts control different pronunciation patterns, depending upon the language, because of the differential reinforcement. German patterns in the presence of English and English patterns in the presence of German are extinguished. For example, the English speaker will initially say "dai" for the German definite feminine article "die" and "din" for the German "dein." But as his proficiency develops as a listener, the student's own reaction to his speech provides a differential result which will weaken the one response and strengthen the other. Such discriminations probably need to be formed, in any event, whenever the student will be exposed to texts. Such a discrimination needs to be made eventually, anyway, as Sapon's experiments have shown (Sapon, 1963).

Use of behavior already in the student's repertoire

The design of the program depended critically on the student's first language. For example, English usage provides many sources of strength for speaking, reading and listening in German. As a result the program would be different for students with different first languages. First, there are the cognate forms as, for example, Mann and man, Wasser and water, ist and is, habe and have, Haar and hair, and so forth. The supplementary control from cognates in English and German becomes stronger when the student acquires sufficient number of usages in which the letters "ss" in German control the same behavior as the "t" in English, as in Wasser and water, Strasse and street. Other common elements between the two languages occur in the word order and parallel form, for example, the man is small, and "der Mann ist klein." In both English and German "the" serves as an autoclitic (Skinner, 1957): a particular man is the subject of the discussion, rather than one of a general class. In other instances, however, German and Spanish are more congruent than English and German. In the usage as in "die Hand des Mannes ist klein" as compared with the Spanish "la mano del hombre es pequena", German and Spanish are more parallel than German and English. Where the texts control very different behaviors in the student's first and second languages, differential reinforcement eventually reduces the induction between the two repertoires. Where the first and second languages have common elements, the texts in the second language continue to be supported by the first language repertoire.

Thematic control

The student's highly developed verbal repertoire in the native language is an important factor in the teaching program. Some of the common repertoire comes from the student's interaction with the physical environment. For example, the moon shines at night, and the sun rises in the morning; dogs, sheep, and cows are animals, but rocks, trees, and water are not; birds, insects and pebbles are small, whereas elephants, mountains and trees are large; the same word is used for two in two animals as in two trees. As a result of the student's first language repertoire, many kinds of verbal development need not be repeated in the second language. Once the student identifies birds as small and elephants as large, he can call ants small and cars large without additional experience.

Pictures provide a frequent source for achieving a thematic effect on the listener. If the student is verbally fluent in a first language, a picture will strengthen a whole class of verbal behavior thematically relevant to the picture. When the student behaves verbally in the second language on the occasion of this picture, the same thematic effect on himself as in the first language will serve as a reinforcer. Moreover the reinforcement will be differentially effective in favor of those responses and intraverbal connections which have the same thematic effect as the picture did in the first language.

Initially, the program draws upon behaviors which can be evoked directly by pictures, such as a man, a boy, a table, or a person eating. Many verbal practices, however, do not fit this paradigm, and the latter stages of the program use thematic sources of strength from the student's native language as a method of transferring a verbal practice from English to German. For example, constructions such as "once upon a time", "yesterday", "however", and "if" have no pictorial counterpart. We taught these kinds of verbal usage by thematic control from the context in which they are used, much as a child comes to be controlled by the word "frigate" because the word appears in the context of sails, sailors, ocean, etc. Contexts in which the student encounters the new words, teach their "meaning" because the behavior controlled by these words is reinforced or extinguished depending on its compatibility with the normal thematic and grammatical control by the rest of the sentence. If, for example, the word "frigate" happened to strengthen verbal responses other than those thematically related to ships, those responses would go unreinforced and hence be weakened. If "frigate" controlled verbal responses thematically related to ships, those responses would be strengthened. The development of complex language in German is simpler if the student already has these forms in his native language. For example, if the student already knows the story of The Three Bears in English, then the words "once upon a time", "a long time ago", "many years ago", "in ages past", etc. will derive strength from the comparable context of the story in the native language. Futhermore, related variations of this expression will supplement each other because of their common elements, all of which are related to time in the student's existing repertoire. For example, the phrase "once upon a time" will influence the student appropriately partly by its position at the beginning of the story because of the student's experience with this phrase in the first language.

Theoretically we expected that the student's behavior in German would be reinforced by the thematic effect on himself as a listener that comes from his experience with *The Three Bears* in English. The general plan, therefore, in this technique of programming is to determine some behavior in the student thematically so that the reinforcement for the second language is "to have the same effect on himself." The following paragraph is an example of thematic programming. This text occurs in section 13 of the program. (The student has been taught all of the usages except those underlined). The thematic effect of the story serves as a reinforcer developing the new verbal control.

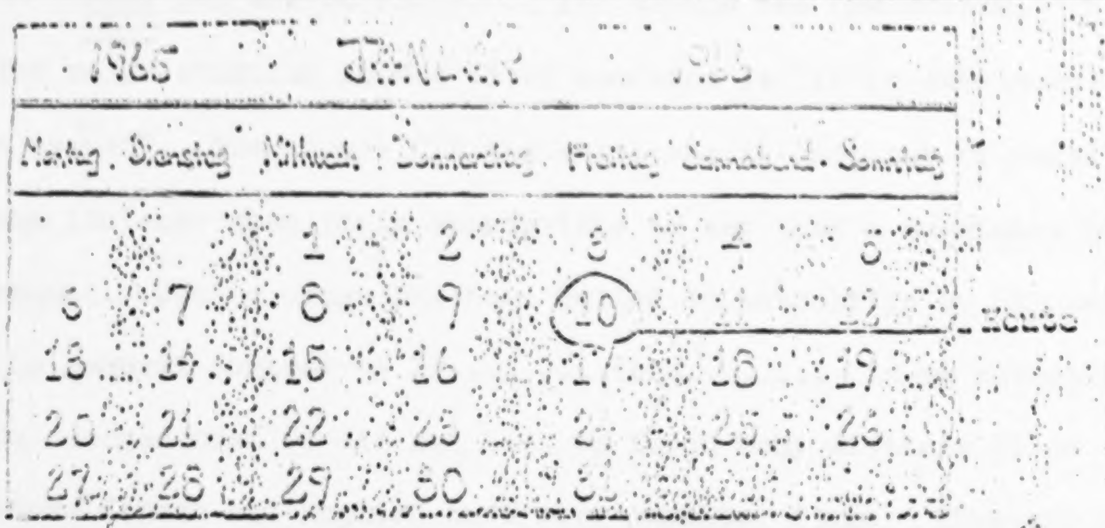
In einem grossen Garten ist ein kleines Mädchen. Sie heisst Helene Bülow. Helene hat einen Bruder. Er heisst Wolfgang. Er ist auch in dem Garten. Helene geht um den Garten herum und sie sieht Wolfgang.

-"Hallo Wolfgang. Guten Morgen."

-"Wo gehst du hin, Helene?"

-"Ich bringe der Mutter diese Blumen. Es sind sechs *rote* *Rosen*. Siehst du, Wolfgang, wie *grün* die Blätter sind? Das Gras und die grossen Bäume sind auch *grün*. Aber die Rosen sind *rot* wie die Lippen. Dieser kleine Busch ist auch *grün*. Aber die Rosen die ich der Mutter bringe sind nicht *grün*. Die *Farbe* der *Rosen* ist *rot*, die *Farbe* der

Blätter ist grün und die Farbe der Sonne ist gelb. Most of the control by "Rosen" comes from its formal correspondence with the English word "rose" but the usages for colors come from thematic effects. Other examples of thematic programming occurred in teaching usage appropriate to time and the calendar. Without familiarity with this usage in the first language it would take considerable verbal development to build such a repertoire since we would not be able to borrow supplementary sources of strength from the first language or use the thematic effect as a reinforcer. Since the student already had much behavior in English under the control of a calendar, the cards such as the following could establish control in German by the stimuli "tomorrow" and "today".



Montag	Dienstag	Mittwoch	Donnerstag	Freitag	Sonnabend	Sonntag
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Morgen wird
Januar, der 9
sein

Morgen wird
Januar, der 11
sein

Morgen wird
Januar, der 12
sein

Heute ist
Januar, der 9

The same result could have been accomplished, using only texts, if the student were already under the appropriate control of the verb tenses, as in the following examples.

Stimulus	Response Alternatives
_______ I went to the store.	Yesterday, Tomorrow
_______ I will see him.	Yesterday, Tomorrow
Yesterday I _____ him.	saw, see

English provides important sources of strength for German, particularly in usages such as in the following sentences.

If the substance is made out of metal it will attract a magnet.

To succeed, work hard.

All men are mortal, some men are spiritual.

When you are in Florence, you should see the museum.

The major stimulus in the first sentence is "if (a substance) will attract a magnet". The phrase "If the substance is made out of metal" instructs the listener when it is appropriate to say that a substance will attract a magnet. Such a usage has been called an autoclitic by Skinner (1957) and the general control by If........ then........ is an autoclitic frame. We assumed that we did not have to teach many of these kinds of usages since German and English have very parallel forms. However, were they not parallel and at those points where the student does not have the needed repertoires, the general techniques of the teaching program could be easily extended to teaching these. In that event, the program could teach young students who have yet to learn a first language.

Review

Review of previously learned material is carefully built into the program but never accomplished by repetition. Practice of already acquired materials is carried out by requiring the earlier usage in an expanded context. For example, thematic usage developed in one section will be reviewed in the next which teaches the proper use of the definite article. Review is also carried out by programming progressively finer contrasts between the response alternatives. The same picture or text may control the same choice but the alternatives give a greater chance of confusion because the incorrect alternatives have more plausibility. One way to review old usage in a new context is to increase the length of an auditory stimulus. For example, a student who can choose a picture of a boy when he hears or reads Junge will be less able to do so, in the context, "Is the boy or girl sitting on the chair?" The choice of a response will be even less sure when the response alternatives, as well as neighboring cards make it possible for the boy to be on the table as well as the chair, depending on the picture. Such expanded contexts provided much of the basis for the review. Contrasts between usages are carefully programmed beginning with stimulus choices which control behavior strongly incompatible with the correct choice. Once the student's behavior is reliably controlled by one level of contrast, the contrasts are made finer, paced with the student's ability to sustain the distinction. Thus the stimulus and the reinforced response remain the same with only the unreinforced alternatives varying. Thus the review is accomplished as the student deals with the old usage in new contexts. The procedure is very similar to that used by Smalley (1961).

RESULTS

Error rate during the program.

Of the ten students who elected to take the program, two could not continue because of schedule conflicts with their regular academic program.

Seven out of the remaining eight students finished the program. None of the students needed to repeat any part of the program. The average number of errors during the program varied between 2% and 3%. Errors were concentrated mainly in sections 3 and 4. Students M, B, C, and E went through the program with an average error rate of 2%. Students D, W, and McL's average error rate was 3%.

Performance on the written intermediate probes (following six lessons)

The students' mistakes will be reported in the following categories:

Sentence structure

a. Completely wrong form.

For example: Die Tür und die Vorderseite ist des Hauses.

b. One or two word order reversals.

For example: Jede Mutter hat mit einem Mann Kinder; nicht wohnt; auch frisst.

Word form

c. Wrong form of nouns and modifiers.

For example: mit die Biene_ und die Füsse_. In dem grosse_ Hause. Die Schaf. Der Auge. Der Sohn hat ein_ Hund.

d. Wrong verb form.

For example: das Mädchen und der Junge trinkt.

e. Various.

For example: nicht instead of nein; auf dem Glas, instead of aus dem Glas.

Spelling

f. Letter reversal.

For example: nien instead of nein; wonht instead of wohnt.

g. Letter omission.

For example: Stü_le; Tis_he.

h. Various.

For example: Inseckten instead of Insekten; Phlanze instead of Pflanze; Ameisle instead of Ameise.

Table 1 is attached.

Table 1 gives each of the student's errors in the probe as percent of the total number of responses. The results are separated by category of error. The letters in the table refer to the categories described in the text. The probes consisted of sentences written by the student in answer to questions given on the tape recorder about a text heard and read by the student prior to the probe. The results of the oral part of the probe will be treated separately.

TABLE 1

ERRORS ON INTERMEDIATE WRITTEN PROBES ARE GIVEN AS PERCENT OF THE TOTAL USAGE. THE SUBCATEGORIES OF ERRORS ARE INDICATED IN THE TEXT.

	STUDENTS	M	B	C	D	E	W	Mc L.
SECTION 4 PROBE AFTER 270 FRAMES 15 SENTENCES	SENTENCE STRUCTURE			10% IN A, 5% IN B				10% IN B
	WORD FORM	1% IN C 1% IN E	10%	% IN D	20% IN C 1% IN E		25% IN C	
	SPELLING		1% IN H	1% IN G	3% IN F	10% IN F 4% IN G	2% IN F 2% IN G	10% IN F.G 1% IN H
SECTION 6 PROBE AFTER 355 FRAMES 17 SENTENCES	SENTENCE STRUCTURE					1% IN B		
	WORD FORM	1% IN C 1% IN E	1% IN D	10% IN D 1% IN E	10% IN C	1% IN E	12% IN C	10% IN C
	SPELLING	5% IN F 1% IN H	1% IN H	3% IN H	5% IN H	1% IN H		3% IN F 5% IN H
SECTION 7 PROBE AFTER 395 FRAMES 10 SENTENCES	SENTENCE STRUCTURE	1% IN B		10% IN A				
	WORD FORM	1% IN D	5% IN C	10% IN D	15% IN C	10% IN C	10% IN C	10% IN C
	SPELLING			1% IN H	1% IN F		1% IN H	1% IN H
SECTION 9 PROBE AFTER 484 FRAMES *	SENTENCE STRUCTURE				15% IN B			10% IN B
	WORD FORM	20% IN C	10% IN C 1% IN E	10% IN C	20% IN C	5% IN C 1% IN D	10% IN C 1% IN D	10% IN C 10% IN D
	SPELLING			2% IN H	5% IN H		1% IN G	1% IN H
SECTION 12 PROBE AFTER 662 FRAMES 23 SENTENCES	SENTENCE STRUCTURE	1% IN B						1% IN B
	WORD FORM	2% IN C	5% IN C 1% IN D	2% IN C	10% IN C 1% IN E	5% IN C		5% IN C
	SPELLING	1% IN G	2% IN H	10% IN H	1% IN H	2% IN H		5% IN H
SECTION 14 PROBE AFTER 820 FRAMES 21 SENTENCES	SENTENCE STRUCTURE							
	WORD FORM	1% IN C	1% IN E	1% IN D 1% IN E	5% IN C 1% IN E	1% IN C	1% IN C 10% IN D	5% IN C 1% IN D
	SPELLING	1% IN H	1% IN G	2% IN H	4% IN H	2% IN G	1% IN H	1% IN H

* IN THIS PROBE THE STUDENT WAS GIVEN A WRITTEN LIST OF 23 WORDS FROM WHICH HE COMPOSED SENTENCES. THE NUMBER OF SENTENCES VARIED FROM STUDENT TO STUDENT AND THE PERCENTAGE WAS CALCULATED FROM THE NUMBER OF SENTENCES WRITTEN BY THE PARTICULAR STUDENT.

The following are examples of some of the behaviors required in the probes and the possible kinds of errors. In the section 4 probe the student wrote with the indirect object, in answer to the question wo. A response required of the student might be as follows:

Der Baum ist neben dem grossen Haus und der Vogel ist auf dem Haus.

In the section 6 probe most of the sentences also involved the indirect object. Two sentences with the possessive were also included. One of these latter sentences was:

Die Tür ist an der Vorderseite des Hauses.

In the section 7 probe the direct object was added. For example:

Die Katze hat einen langen Schwanz.

In the section 9 probe the students composed sentences. Twenty-three words were chosen from the preceding section in the program and the student was asked to compose sentences with these words.

In the section 12 and 14 probes all the usages developed in the program were involved. The questions required more complex answers. For example:

Eine kleine Familie wohnt in einem grossen Haus in der Nähe des Waldes. Der Sohn hat einen kleinen Hund und die Tochter hat eine kleine Katze.

Even though the student did not have to write or speak to a listener during the automatic part of the program, the performances during the intermediate written probes showed considerable ability to write and speak appropriate to the material of each lesson. Sentences which were not understandable to the instructor were an exception. The percentage of errors in declined forms was relatively low and tended to decrease as the students advanced in the program. The errors in spelling were also relatively few and tended to decrease.

Pronunciation development

Students began to correct pronunciation errors, themselves, as early as section 2 (students M, B, E, and McL.) or on section 3 (students D, C, W). Student W's self-correction occurred less frequently but became more regular after section 5. A student's first attempt at self-correction was not always successful. Up to section 8, students M, B, and E corrected difficult pronunciation patterns more successfully when they heard the correct form. After section 8, however, these students were able to pronounce difficult sounds correctly even in the absence of auditory stimuli. For students W. and McL., correct pronunciation in the absence of auditory stimuli occurred only after section 10.

As a general rule, the level of accuracy in pronunciation was lower at the beginning and higher at the end of the section. For students M, B, and E this level did rise progressively after section 5. For the other students, the progress up to section 10 was slower.

Student M. (training in French and Latin) reversed the ie and ei phonemes. He overcame this difficulty by section 5. Although he had difficulties with the Umlaut ö, ü and ä, the ch (Buch), the initial z or zw sounds (Zunge, zwei) - he progressed fairly rapidly toward a credible pronunciation in these sounds.

Student B. (quite fluent in French - some training in Latin) reversed the ie and ei phonemes. This problem was solved by section 3. His main difficulties were: the Umlaut ö and ü, the ch sound and the initial z and zw sounds. His progress in these sounds was very slow until section 5. He had a tendency of stressing the final syllables (as in French).

Student E. (training in French and Latin) reversed the ie and ei phonemes. This problem was solved by section 2. He had some difficulties with ch, initial z and zw sounds. His progress in these sounds was fairly rapid. He had no trouble with the Umlaut and his general initial level in accuracy was the best.

Students C, D, W, and McL. had problems with all the new sounds in varying degrees.

Student C. (a small amount of training in French) reversed ie and ei phonemes, until section 3. He had difficulties with all the other German sounds. From section 4 onward, he repeated difficult sounds (such as ö, ü, ä, ch, end sounds of r, initial z and zw, etc.) to himself. In his self-corrections he improved first in the "Umlaut", and next in the ch. By section 10 he was showing a general improvement.

Student D. (training in French) had no problems with ie and ei phonemes. He had the same general difficulties as Student C. His pronunciation of the "Umlaut" began improving at section 6 and his progress was slower than that of Student C.

Student W. (training in French and Latin). He reversed ie and ei phonemes up until section 8. From section 3 onward the frequency of reversal became lower as his self-correction in these phonemes became more frequent. But he very often relapsed into incorrect pronunciation until section 8. The difficulties with the "Umlaut" ü and with the ch sound followed the same pattern as those of ie and ei reversals. Though there was gradual improvement, he frequently reverted to less accurate pronunciation of the *ü* and the *ch* even after section 10.

Student Mc.L. (5 years of Spanish in high school). This student had far more pronunciation difficulties than all the others. His first reading test was even far from the rough initial approximations of the other students. By section 2 he began to correct himself but even the corrections were not successful. He also failed in his attempts to correct the initial *z*, *zw* and *ch* (as in Buch) even though the frequency of his repetitions was much higher than the other students. By section 5 however he pronounced most of the Umlaut sounds in a very acceptable form except in Bücher where the difficulties with the combination of the two sounds in one word disrupted the performance. By sections 9 and 10 his pronunciation of even the most difficult sounds had greatly improved. Considering his initial difficulties, this student's progress was the

Considering his initial difficulties, this student's progress was the

more dramatic.

While the students' pronunciation showed English influences even after the program, we judged their progress toward correct patterns was at least that achieved by most students after a semester of study in a conventional college course.

Rate of work

Table 8 shows the amount of time each of the seven students spent taking the teaching program.

Table 2

Hours of work

Students	on the program	on the written intermediate probes	with the monitor*	Total
E	8.17	1.50	4.15	14.20
M	7.10	2.05	5.10	14.25
D	8.02	2.10	4.40	14.50
B	8.59	1.50	4.35	14.44
C	7.45	1.55	5.15	14.55
Mc.L.	9.27	1.55	5.40	17.00
W	9.55	2.30	6.20	18.45

* Oral probes and correction of the written probes

The total time to complete the program ranged from 14 to 18 hours with about half of the time spent on the written probes and in oral interaction with the monitor. The time spent on each card ranged between 20 to 30 seconds.

The Final Probe

The students wrote from 8 to 15 sentences in each of the seven parts of the probe. Each student wrote between 60 and 90 sentences in all.

Students M, B, C, D, and E wrote sentences using most of the declined forms taught in the program and composed new sentences, not used in the program. The two students, whose error level was highest, McL. and W, composed sentences which were closer to the structures and word forms taught in the course.

In the following data, the students' errors are reported as errors in sentence structure, word form and spelling. A few sentences taken from each student's probe are also given to illustrate the general form of their compositions, which were written without any thematic or textual support. The letters refer to the details of structure, word form and spelling described on page 24.

Student M wrote a total of 98 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
0	4	19	0	4	1	2	3

Ein haus ist in der Mitte des Gartens und in der NÄhe des Waldes. In diesem Haus wohnt eine Familie mit vier Personen, ein Vater, eine Mutter, ein Sohn und eine Tochter. Der Sohn geht in den Wald. In dem Wald wohnen die Tiere und die Pflanzen.

Student [illegible] wrote a total of 91 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
0	5	23	5	0	1	7	3

Er wohnt in "Mars" aber er hat zwei Ohren an beiden Seiten des Gesichtes. Das Haar der Frau ist lang aber das Haar der Männer ist kurz. Diese Blätter sind nicht grün: der Baum hat kein Wasser. Das Gras um den Baum herum ist nicht grün.

Student C wrote a total of 76 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
0	0	21	2	1	2	2	7

Die Sonne geht auf. Es ist früh. Ich liege in meinem Bett; ich schlafe nicht. Ich bin wach. Ich gehe in das Esszimmer. Mein Vater, meine Mutter und ich essen Brot mit Honig oder Butter. Wir trinken Kaffee mit Milch oder Zucker.

Student D wrote a total of 65 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
2	0	11	0	0	0	3	9

Ich bin ein Student in der Georgetown Universität. Ich studiere Deutsch. Ich bin achtzehn Jahre alt. Meine Brüder sind Tim, Pat und Mike. Ich habe keine Schwester. Pat und Mike sind Zwilinge. Sie sind zehn Jahre alt.

Student E wrote a total of 63 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
0	2	22	1	0	2	5	0

Auf dem ersten Bild ist ein Stuhl vor dem Tisch und auf dem Tisch sind ein Glas und ein Teller. Auf dem zweiten Bild ist ein Haus. Ein Baum ist vor dem Haus und ein Vogel ist über dem Haus. Die anderen Karten haben Bäume mit wenigen und vielen Blättern.

Student Mc.L wrote a total of 87 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
3	0	31	1	3	0	5	1

Ein Vater und eine Mutter haben zwei Kinder. Der Mann ist der Vater und die Frau ist die Mutter. Das Mädchen ist die Tochter und der Junge ist der Sohn. Das Mädchen ist elf Jahre alt und der Sohn ist vierzehn Jahre alt. Diese kleine Familie wohnt in einem grossen Haus.

Student W wrote a total of 82 sentences.

Errors

sentence structure		word form			spelling		
a	b	c	d	e	f	g	h
0	3	33	2	0	8	7	15

Die Personen trinken Bier aber die Katze trinkt Milch. Eine Person isst Brot mit Butter und Honig. Die Bären fressen auch Honig. Die Bären leben in dem Wald. Die Bären sind grosse Tiere. Sie schlafen in dem Gras unter dem Baum.

The following text composed by Student C during the final written probe is an example of the range of structures and usages of which the student is capable at the end of the program.

1. Bitte schreiben Sie einige Sätze über ein Thema des Programmes.

D~~er~~ie Sonne geht auf. Es ist früh. Ich liege in meinem Bett; ich schlafe nicht. Ich bin wach. Ich gehe in das Esszimmer. Mein Vater, meine Mutter und ich essen Brot mit Honig oder Butter. Wir trinken Kaffee mit Milch und Zucker. Mein Bruder und meine Schwester sind nicht in dem Esszimmer. Sie sind in dem Schlafzimmer; sie schlafen. Die Betten sind in dem Schlafzimmer, und ein Tisch und viele Stühle sind in dem Esszimmer. Es ist Sonnabend. Ich lerne Deutsch in der Georgetown Universität.

2. Bitte schreiben Sie einige Sätze über ein anderes Thema des Programmes.

Helene Bülow ist in einem Garten. Es ist ein kleines Mädchen. Sie ha~~b~~t viele Blumen in de~~m~~n Händen. Der Vater dieses Kliehes Mädchen ist

Herr Bülow und die Mutter ist Frau Bülow. Der Bruder heisst Wolfgang. Wolfgang sie~~g~~ht Helene in dem Garten. "Guten Morgen, Helene. Wie geht es dir ~~Sie~~?" "Danke, und dir ~~Ihnen~~?" "Danke, gut." "Geh~~t~~en wir in d~~en~~as Haus und trinken wir Kaffee und essen wir Brot mit d~~ie~~er Mutter." "Ja, gut."

3. Hier ist die Liste der Themen des Programmes. Bitte schreiben Sie einige Sätze über die anderen Themen.

Das Haus ist in der Nähe des Waldes. Es ist auch in der Mitte des Gartens. Das Haus hat eine Vorderseite und drei Sieten. Eine Tür und ein Fenster sind ~~i~~an de~~m~~r Vorderseite und drei Fenster sind ~~i~~an jeder Seite. Das Haus hat auch ein Dach. Das Dach hat auch ein Fenster. Das Dach hat keine Tür. Eine kleine Familie wohnt in dem Haus. Der Vater und die Mutter sind die Eltern und der Sohn und die Tochter sind die Kinder. Ein Tisch und viele Stühle sind auch in dem Hause. Viele Tiere leben in dem Wald. Pflanzen leben auch in dem Wald. Die Bären und die Bäume sind in dem Wald. Die Blumen sind in dem Garten.

4. Hier sind einige Bilder des Programmes. Bitte schreiben Sie einige Sätze über diese Bilder.

Die Kühe und die Katzen trinken Wasser. D~~ie~~as Schaf frisst Gras und das Pferd frisst Blätter. Der Junge isst Brot mit Honig oder Butter. Die Blume ist offen. Der Junge hat viele Haare. Ein Mann hat keine Haare und der andere~~s~~ hat wenig. Der Elefant hat einen grossen Körper und der Vogel hat einen kleinen Körper. Der Junge isst einen Äpfel. Viele Äpfel sind in dem Teller und zwei Äpfel sind auf dem Tisch. Die Schachtel ist offen. Ein~~er~~ Schuh ist neben den Schachteln. Die Tasse ist zwischen den Schachteln. Die grosse~~r~~ Schlange hat einen langen Schwanz, und die kleine~~n~~ Schlange hat einen kur~~t~~zen Schwanz. Das Mädchen trinkt Milch.

5. Hier ist die Liste der Wörter des Programmes. Bitte schreiben Sie einige Sätze mit diesen Wörtern.

Der Vogel hat zwei Flügel. Der Hund lebt in dem kleinen Haus. Eine Person hat zwei Hände. Die Fliege ist ein~~en~~ Insekt. Der Hals ist zwischen dem Kopf und dem Rumpf. Die Lippen und die Rosen sind rot. D~~er~~ie Sonne ist gelb. Die Zähne sind in dem Mund.

6. Bitte schreiben Sie einige Sätze über "Die drei Bären" die in dem Wald wohnen.

Die drei Bären leben in dem Wald. Der Vater und die Mutter und der Sohn fressen Honig. Die Biene macht Honig. Die Bären gehen ~~zu~~ um den Baum mit dem Honig. Es ist nicht gut. Die Bären haben nicht Honig. Die Bienen haben d~~ie~~en Honig. Die Bären schlafen nicht in d~~as~~em Bett. Sie schlafen in dem Wald. In De~~c~~zember, im Januar und im Februar sie schlafen. "Die Bären sind in diese~~s~~m Wald." Die ~~p~~Personen gehen nicht in diese~~s~~n Wald.

The final oral probe

The oral probe consisted of a conversation with the instructor and questions about some of the pictures presented in the program. The following was the conversation with Student E taken from the tape recording. The texts are presented as approximations of their vocal counterparts. How closely the student's pronunciation conforms to standard forms has been discussed already.

	Teacher	Student
1.	Guten Tag.	Guten Tag.
2.	Wie geht es Ihnen?	Danke, gut. Und Ihnen Frau Silva?
3.	Danke, gut. Wie heissen Sie?	Ich heisse Evans.
4.	Wie alt sind Sie?	Ich bin zwanzig Jahre alt.
5.	Sind Sie ein Student?	Ja, ich bin ein Student.
6.	Wo studieren Sie?	Ich studiere in der Georgetown Universität.
7.	Wo wohnen Sie?	Ich wohne in Massachusetts.

8.	Wo wohnen Ihre Eltern?	Sie wohnen auch in Massachusetts.
9.	Haben Sie viele Brüder?	Nein, ich habe nur zwei Brüder.
10.	Haben Sie auch Schwestern?	Ja, ich habe zwei Schwestern.
11.	Wie heissen Ihre Schwestern?	Meine Schwestern heissen Ora und Mara.
12.	Wie alt sind Ihre Brüder?	Meine Brüder sind ein-und zwanzig und zehn Jahre alt.
13.	Herr Evans, sagen Sie mir, bitte, die Tage der Woche.	Die Tage der Woche sind: Montag, Dienstag, Mittwoch, Donnerstag, Freitag, Sonnabend, Sonntag.
14.	Welcher ist der erste Monat des Jahres?	Der erste Monat des Jahres ist Januar.
15.	Und der letzte?	Der letzte ist Dezember.
16.	Herr Evans, welche sind die Artikel auf Deutsch?	Die Artikel auf Deutsch sind der, die, das, ein, eine.
17.	Wie schreibt man die Substantive auf Deutsch?	Mit einem grossen Buchstabe.

At this point the student was shown pictures, as indicated, and the student responded to oral questions.

18.	Was ist das?	Das ist ein Wald.
19.	Was sind diese Tiere?	Diese Tiere sind Bären.
20.	Schläft dieses Mädchen oder ist sie wach?	Dieses Mädchen schläft.
21.	Und diese Personen?	Diese Personen sind wach. Sie liegen auf dem Boden.
22.	Wo ist dieses Buch?	Unter dem Stuhl.
23.	Und die Tasse?	Die Tasse ist neben der Flasche.
24.	Wo ist dieser Junge?	Dieser Junge ist hinter dem Baum.
25.	Und dieser?	Dieser Junge ist vor dem Baum.
26.	Wieviele Bücher sind offen?	Ein Buch ist offen.
27.	Und wieviele sind geschlossen?	Zwei Bücher sind geschlossen.
28.	Ist dieser Mann alt?	Nein, dieser Mann ist Jung.
29.	Und dieser?	Dieser ist alt.
30.	Wie hält diese Frau das Baby?	Sie hält das Baby in beiden Armen.
31.	Wer hat lange Haare, der Junge oder das Mädchen?	Das Mädchen hat lange Haare.
32.	Wo sind die Ohren?	Die Ohren sind an beiden Seiten des Gesichtes.
33.	Wo ist der Ellbogen?	Der Ellbogen ist in der Mitte des Armes.
34.	Und die Nase?	Die Nase ist in der Mitte des Gesichtes.
35.	Wo sind diese Stühle.	Diese Stühle sind um den Tisch herum.
36.	Gut, danke Herr Evans.	Bitte, Frau Silva.
37.	Auf wiedersehen, Herr Evans.	Auf wiedersehen, Frau Silva.

DISCUSSION

For purposes of our experiment we have restricted the student's experience to the multiple choice procedure and the probes. Nevertheless, the student gained proficiency as a speaker and writer even though his training experiences were, with limited exceptions, restricted to listening and reading. There was a substantial rate of development of ability to pronounce the language, despite the absence of any experiences in which the program provided direct consequences for the student's pronunciation. These results supply confirmation to our hypotheses underlying the basic construction of the program that training the student as a listener would influence proficiency in speaking. Nevertheless, we do not recommend this program as a sole experience, since other types of procedures are useful for different outcomes. Yet it is clear that it is possible to develop an active use of basic parts of a language with a simple automatic program taken over a short period of time.

After taking the program, the students pronounce German sufficiently well that any German listener would have no difficulty in understanding them; nevertheless, their approximation of correct German pronunciation is still gross, and we do not know how closely an approach as outlined here can approximate the nuances of German pronunciation we refer to as a good accent. It seems reasonable to expect that new conditions of reinforcement are required to produce exact conformation to German pronunciation patterns beyond that which is required simply to have a native listener understand. In any event, it seems reasonable to experiment with procedures that postpone such experiences until the student has mastered many of the other aspects of the use of the language. The critical research that will be needed will be experiments in which the point-to-point change in the students' pronunciation is measured as a function of different levels of proficiency as a listener. The use of the teaching program as a practical classroom device would be limited by the large amount of time needed to administer the probe. Although the probe was not a teaching device in the usual sense, we judged it to be an important factor in the program's effectiveness. Many modifications of the probe procedure used in this experiment could be proposed as a result of our experiences. Some of the functions of the probe could be carried out in a group in the classroom, where the students in recitation, conversation or oral examinations could demonstrate the newly acquired repertoires. We have begun to experiment with probes which are semi-automatically administered through appropriate texts and tape recordings. These lack, however, a sure criterion to objectively determine whether the student has achieved sufficient mastery to go on to the next lesson. Perhaps a solution might be a combination of automatic probes, classroom procedures and periodic diagnostic tests. Despite the large amount of time spent with the probes, they did not instruct in the usual sense that we speak of teaching. The major event in the probe was that the student was given an opportunity to observe his own achievement. We judge this reinforcer to be an important factor in the effectiveness of the program. Even though the probe did not teach in the usual sense it provided a reinforcer which determined the form of the student's behavior as he operated the teaching machine.

The program which we described is only a first approximation and will require significant modification as a result of experiences with the first test and subsequent, more extensive testing. Major problems of redesign should include a more rational basis of the choice of the initial vocabulary, more natural usage, and the sequence by which it is included in the program.

The present experiment used English-speaking students, whose basic pronunciation patterns and general structure of the native language is very similar to that of German. Since one of the properties of the program described above is the potentiality of transcribing it, almost directly, into many other languages, additional research will be required in studying the problems raised by differences among languages. Many of these problems might be anticipated by linguistic analyses. These problems will be more acute where either the native language or the second language contains pronunciation patterns which are very different from those in the language to be taught.

We are extending the same principles and technique to the problems of dislexia and reading instruction with young children. Just as with second language instruction, the matching-to-sample procedure, with the probe procedure, is a way to teach reading automatically without direct reinforcement of the student's vocal behavior.

While the experimenters had some training in phonetics and could make at least a rough phonetic analysis of the student's responses, the results were reported only in enough detail to convey gross changes. To measure the effects on pronunciation patterns of training the student as a listener, more careful experiments are needed, such as:

1. Careful measurement of the student's initial pronunciation patterns, as a speaker, a reader, and in free speech.

2. Training of the student as a listener, carried out objectively so that the change in the student's articulation can be related point to point to the changes in the student's perception of the sounds.

3. A phonetic analysis of the changes in the student's pronunciation.

We take the results of the present experiment, however, to confirm the importance of the listening function and encourage us in the direction of more fine grain experiments. We judge that the reason other investigators (Liberman, 1957; Mace, 1965; Underwood & Schultz, 1960) have not confirmed this hypothesis is that the training of the student as a listener did not use critical contrasts during the discrimination training so that the student was not forced to attend to the details of the spoken sounds that form the basis for the fine grain articulation patterns that are necessary for accurate pronunciation.

References

Brooks, N. Language and language learning; theory and practice. New York: Harcourt Brace, 1960.

Ferster, C. B. Intermittent reinforcement of matching to sample in the pigeon. J. exp. Anal. Behav., 1960, 3, 259-272.

Ferster, C. B. Arithmetic behavior in chimpanzees. Scientific American. 1964, 210, 98-106.

Lane, H. L. Programmed learning of a second language, 1964.

Liberman, A. M. Some results of research on speech perception. J. acoust. Soc. Amer., 1957, 29, 117-123.

Mace, L. Response differentiation and stimulus discrimination in learning French. Doctoral dissertation, University of California, Los Angeles, 1965.

Richards, I. A., Gliste, I. E., & Gibson, Christine. Italian through pictures, Washington Square Press, Inc., New York, 1960.

Sapon, S. An application of psychological theory to pronunciation problems in second language lerrning. Modern Language Journal, 36, March, 1952.

Sapon, S. Report on the use of a programmed course in Spanish. Unpublished report, Ohio State Univ., Columbus, 1961.

Skinner, B. F. Verbal Behavior, New York: Appleton-Century-Crofts, 1957.

Smalley, W. A. Manual of Articulatory Phonetics, Tarrytown, New York. Practical Anthropology, 1961.

Underwood, B. J. & Schultz, R. W. Meaningfulness in verbal learning. New York. Lippincott, 1960.

Footnotes

1. This research was carried out under Contract No. DA-49-193-MD-2577 with the Office of the Surgeon General and Grant No. 5-K3-MH-5744 of the National Institutes of Mental Health.

2. We are indebted to Father E. P. Dineen, Professor of German at Georgetown University, for making the experimental test possible.

3. A first version of the German program was written by Irene Jones under the supervision of C. B. Ferster. M. I. Rocha e Silva was responsible for a radical revision, extension of the content and scope of the program, and the empirical trial at Georgetown University. C. B. Ferster was responsible for the functional analysis of verbal behavior and its extension to the program construction.

4. We are indebted to the Department of Design, Southern Illinois University and Professor Harold Cohen for their help in redesigning an earlier version of the teaching machine.

Figure 1. A photograph of the teaching machine used for the matching-to sample procedure.

Figure 2. Six sample cards from the teaching program illustrating the verbal arrangements that were used on the cards during the program. The "text", exposed by the cutaway portion of the card, indicates the auditory sample which the student hears when he presses the button. When the card is intact the student responds to the text, picture, or combination of picture and text at the top of the card.

Vietnamese

The Vietnamese program, modeled after the German in content programming technique and general method of classroom application, was used mainly as a baseline for the experiments which measured the effects of motivational variables. Nevertheless the program, despite its lack of empirical revision and some of the subtleties of design present in the German program, turned out to be surprisingly effective as a teaching instrument. A pilot experiment carried out by the IBR at the War College with ten Army Officers was successful enough that the Institute for Behavioral Research has submitted bids on teaching contracts to apply the teaching program and methods more broadly to military training problems.

Experiments with the Vietnamese show the possibility of adapting the general approach to other languages even though they are quite different from German. Vietnamese, for example, is a tonal language much less congruent to English than German.

II.

The Effects of Listening Discrimination Training Upon Echoic Accuracy

INTRODUCTION

In teaching a second language to students a problem that frequently, if not invariably, arises is the necessity for the student to learn to pronounce certain sounds which are not in his first language repertoire. Sometimes these sounds are merely a novel combination of two or more sounds that the student already produces. In other cases, sounds very different from those present in the subject's repertoire need to be learned, sounds which may necessitate learning responses incompatible with his first language. Teaching a second language, using techniques of programmed instruction, does not eliminate this problem. In fact, it makes the problem even more difficult to solve since an instructor is not present with the student to shape his speech into the correct pronunciation forms. It is, therefore, of some practical as well as theoretical interest to investigate various procedures for the development of good pronunciation which could be accommodated within a programmed language course.

One of the first procedures that suggests itself for this task is that students be trained to distinguish between correct and incorrect pronunciation. Thus the students might be better able to listen to and "shape" their own vocalizations toward correct pronunciation.

Listening Discrimination Training

This hypothesis is the one that served as the basis for the design of the Vietnamese and German instructional programs which were also developed under this contract (Ferster and Silva, 1966). In these courses of instruction and program materials the student is trained as a listener and a reader while the performances required of him are those of speaking and writing. The results of these experiments suggest that the listening and reading repertoires are effective steps toward developing speaking and writing. However, to date very few controlled laboratory studies have been reported in which explicit measurements are made of the relation between these repertoires. Lane and Schneider (1963) employed an echoic task where subjects mimicked a Thai phoneme. The response parameters of interest in this study were the correspondences in pitch slope (rate of change in pitch) and response duration between the echoic stimulus and the subject's echoic response.

Following the echoic task subjects listened to a tape on which five different Thai tonemes were presented in irregular order. The subjects were trained to make a response only when the toneme previously used as the echoic stimulus was heard. Lane and Schneider found that this type of discrimination training produced little improvement in subjects' echoic accuracy.

Pimsleur, Mace and Keislar (1961) and Pimsleur (1963) have reported the effects of listening discrimination training upon high school students' pronunciation of French words. In one part of the study (Final Experiment I) a listening discrimination procedure was programmed in which subjects discriminated between French words which contained the French [o] and the typical American mispronunciation of these words which contained a diphthonged $[o^{u}]$. (The American mispronunciations were actually English counterpart words.) After some preliminary training, subjects heard each word and responded indicating whether the pronunciation was French or American. Although the subjects were relatively accurate in discriminating between the French words and the English counterpart words, their pronunciation of the French words when they read them from a list was no better than the pronunciation of subjects in a control group who received no prior listening discrimination training. However, two qualifications should be added. Apparently the French words on the listening discrimination tape were pronounced by a different person (or persons) than were the English counterpart words. It seems at least possible then that the accuracy of subject's judgment in telling French from English pronunciation could be due to subjects making a discrimination between the voices of different speakers rather than between the French and the English words _per se_. Another complication of these experiments is the control of the pronunciation patterns by the textual stimuli. It is well know to linguists that a student who may pronounce a second language appropriately on imitation is likely to shift to an English pronunciation pattern in the face of a textual stimulus when he reads. Further, after the pronunciation test was completed -- a response indicating whether the word heard was a French one or an English counterpart one -- was readministered to the experimental subjects and administered for the first time to the control subjects (Pimsleur, Mace and Keisler, 1961). While the experimental subjects were more accurate on this test than the controls the difference between the groups was slight indicating the possibility that either subjects already had this listening discrimination in their repertoires prior to training or, again, that the discrimination was based on voice quality differences between different speakers rather than the vowel difference between the French and English words.

In the second part of this study (Final Experiment II) a listening discrimination procedure was programmed in which the experimental subjects were taught to discriminate among words containing three French nasal vowels and the control subjects only listened to the French words as they silently read aloud from a list of French words which contained nasal vowels. Subjects' pronunciations were judged by native French raters on the basis of comprehensibility. The mean score of the experimental subjects was significantly higher on the pronunciation list, indicating better pronunciation, than was the mean score of the control subjects.

In neither of these studies is it entirely clear what type of auditory stimuli the subjects were discriminating among in relation to the actual errors that the subjects made in their attempt to produce the sounds in question. For example, to train the subject to discriminate auditorily between correct examples of a vocalization and certain types of incorrect vocalizations, may have little function for the subject's speech if he never makes those particular kinds of errors when speaking. The most relevant kind of listening training would appear to be a procedure in which subjects are trained to discriminate among correct vocalization and incorrect vocalizations of the type that the subject commonly makes when he attempts to either reproduce or mimic a certain vocalization.

The purpose of the present pilot study, then, was to investigate the effects of this kind of listening discrimination upon echoic accuracy.

PROCEDURE

Echoic Task

In order to obtain a sample of sounds which subjects had problems in pronouncing, a number of Vietnamese phonemes were recorded by a Vietnamese speaker. These phonemes were then presented to subjects who attempted to mimic them. From this sample, one vowel sound [ư] was found which subjects consistently mispronounced both when it was presented alone and in combination with other

Vietnamese phonemes. A number of recordings were made of the ư vowel by a Vietnamese speaker with linguistic training, and a sample of 30 was selected which were judged by him to be accurate productions of the vowel. These 30 ư vowels then were re-recorded onto a single tape, each separated by two seconds of silent tape. Subjects listened to the tape of these 30 ư vowels through earphones. Their instructions were to listen to these sounds and, in the silent interval which followed, to mimic the sound as accurately as they could. Subjects heard their own attempts at mimicry through the earphones.

Scoring Echoic Responses of Subjects

There are a number of ways in which vowel sounds may be described: physically, by a spectographic analysis of the vowel sounds; behaviorally, by specification of the behavior (e.g., tongue position in the oral cavity, amount of roundness of the lips, etc.) required to produce the sound; and behaviorally in terms of a listener by the construction of rating measures and having native speakers of a language rate the intelligibility or correctness of the sound produced. For our purposes, the Vietnamese vowel was specified in terms of the lip and tongue positions required to produce it. For lip position the characteristic of interest was the degree of roundness or unroundness of the lips during the subject's pronunciations of the ư's. This was judged by the experimenter who observed subjects in the experimental situation. For tongue position the characteristic of interest was the relative location (front-back, high-low) of the highest arched portion of the tongue in the oral cavity. This was judged by a linguist and a person with some training in phonetics from the tape recording of subjects' performances on the echoic task.

In general, a correct production of the ư vowel requires (within limits) that the highest arched portion of the tongue be in the high back portion of the oral cavity, and the lips be distinctly unrounded. As far as tongue position is concerned the closest English equivalent is the "o͞o" sound as in boot, although the tongue position for the ư is slightly higher than for the English "o͞o". In addition, the "o͞o" in English is produced with the lips rounded, whereas the Vietnamese ư is produced with the lips distinctly unrounded. When subjects were tested on the echoic tape four types of errors were noted: 1) lip rounding throughout -- the subject's vocalization was produced with the tongue in roughly the correct position, but the lips were rounded throughout the mimicry; 2) tongue position forward and low -- the subject's vocalization was produced with the tongue position too far forward and low, with the lips partially rounded; 3) fairly extreme lip rounding at the end of the vocalization; 4) a centralized off-glide at the end of the vocalization; that is, the tongue position frequently "glided off" into the central portion of the oral cavity with the lips moving to an unrounded position. The types of pronunciation errors described above were not mutually exclusive; frequently errors (1) and (4), (2) and (4), and (2) and (3) occurred together in one vocalization.

Listening Discrimination Task

Two types of listening discrimination procedures were used: (1) subjects listened to two vocalizations, one following another, and pressed a button indicating whether these vocalizations were either the "same" or "different"; (2) subjects listened to a single vocalization and then pressed the button indicating whether the vocalization was a "correct" or an "incorrect" example of the ư vowel. Within each of these general types of listening discrimination a number of kinds of stimuli were employed which varied for each subject. The basic rationale of the listening discrimination procedure though was to train subjects to make differential responses among stimuli which contained correct and incorrect characteristics; further, that the incorrect stimuli be of the general type that the subjects produced when they attempted to mimic the ư sound on the echoic task.

During the listening discrimination procedure subjects listened to correct and incorrect ư stimuli produced by the same person who recorded the stimuli for the echoic task. Incorrect stimuli differed from correct ư vowels in the following ways: the highest arched portion of the tongue was too far forward and too low (extreme and slight versions); lip rounding at the end of the vocalization (extreme and slight versions); centralized off-glide at the end of the vocalization (extreme and slight versions).

During each experimental session the subjects first went through the echoic task where they attempted to mimic the 30 u˞ stimuli. Then they went through the listening discrimination procedure which was followed by a repetition of the echoic task.

RESULTS

Very early in the listening discrimination it was discovered that the subjects entered the experimental situation with a relatively accurate repertoire of judging the "sameness" of two vocal stimuli presented one following another. This was true whether a "same" pair of stimuli was the identical stimulus re-recorded twice or a pair of two different but correct u˞ stimuli. Similarly the subjects were highly accurate in recognizing "different" pairs, that is, a pair which contained an incorrect u˞, no matter what type of error the incorrect stimulus contained. Thus for the same-different comparison there was little to train the subject to discriminate. Nevertheless both the subjects continued to mimic the u˞ stimuli incorrectly. The results of the listening discrimination procedure when single stimuli were presented and the subjects required to judge its correctness or incorrectness were quite different from the same-different comparisons. For the correct-incorrect judgment there was initially a high error rate which decreased gradually over sessions. Concurrently, as subjects became more accurate in judging the sounds presented singly their vocal productions in some characteristics became more accurate. This relationship will be summarized separately for each subject.

Subject 1

Subject 1's steady state performance in mimicking the u' stimuli contained errors of the following type: (1) highest arched portion of the tongue too low and too far forward (98 percent of trials); (2) centralized off-glide at the end of the vocalization (27 percent of trials); (3) extreme lip rounding at the end of vocalization (11 percent of trials).

Tapes containing a number of correct u' vowels and incorrect vocalizations were made separately for each type of error and for the extreme and slight versions of each type of error. Initially, Subject 1 was presented with a tape containing the extreme version of one type of error. Once he achieved an error rate of less than 5 percent in judging these stimuli a tape containing the slight version of that error was used. After Subject 1 had achieved an error rate of less than 5 percent on all tapes with the slight error stimuli the stimuli were combined so that Subject 1 had to discriminate between correct examples of the u' vowel and three types of slight mispronunciations of that vowel which were all contained on one tape.

Within the listening discrimination procedure itself there were two general characteristics of Subject 1's performance to be noted: (1) the discrimination among the correct stimuli and the error stimuli where the tongue was too low and forward was much more difficult than discrimination of the other two types of errors; (2) when all three types of errors were included on one tape interspersed with correct ɯ stimuli the accuracy of Subject 1's performance in judging the correctness of each sound initially dropped markedly, even though these were the identical stimuli to which the subject had been highly accurate previously when only one type of error was included within each discrimination tape.

As Subject 1 came under the discriminative control of the correct and incorrect type of stimuli on the listening tapes, two changes were noted in the accuracy of his mimicry on the echoic stimuli. First, the percentage of echoic trials on which there was a centralized off-glide at the end of the vocalization dropped from approximately 27 percent to approximately 2 percent. Second, the percentage of echoic trials on which there was lip rounding at the end of the vocalization dropped from 11 percent to less than 1 percent. Neither of these changes occurred in an abrupt fashion, but occurred gradually (and with a considerable amount of variability) as listening discrimination progressed. There were no changes noted in mimicking accuracy as far as tongue position was concerned.

Subject 2

Subject 2's steady performance in mimicking the u/ stimuli contained errors of the following types: (1) highest arched portion of the tongue too low and too far forward (97 percent of trials); (2) centralized off-glide at the end of vocalization (18 percent of trials).

Subject 2 was put through a program of listening discrimination (correct-incorrect) similar to that used for Subject 1. Initially for Subject 2, listening tapes containing only the errors of tongue too low and too far forward and centralized off-glide were used. However, because Subject 2 began to exhibit lip rounding errors after the listening discrimination procedures began, listening tapes which contained lip rounding error stimuli were also included in the discrimination program.

Subject 2 began on the tape containing correct u/ stimuli and each type of error in its extreme form. When she had achieved an error rate of 5 percent or less on these tapes she moved on to the tape containing each type of error in its slight form, then onto the tape containing all three types of errors in their slight form on one tape.

For the listening discrimination procedure the same two characteristics were noted in Subject 2's performance as for Subject 1. First, the discrimination among u/ stimuli and the stimuli where the tongue was too low and too far forward was much more difficult than the discrimination among correct u˞ stimuli and the other two types of error stimuli. Second, when the listening tape was introduced which contained all three types of error stimuli, an initial decrease in accuracy of performance was obtained.

As Subject 2 came under the discriminative control of the correct and incorrect type of stimuli on the listening tape, several changes were noted in her echoic accuracy. First, the percentage of echoic trials on which there was a centralized offglide dropped from approximately 18 percent to less than one percent. Concurrently, however, the percentage of the echoic trials on which there was lip rounding at the end of the vocalization increased from zero percent to approximately 12 percent. However, once listening tapes containing the lip rounding stimuli were introduced and mastered, lip rounding errors at the end of vocalizations dropped to less than one percent. Again these changes in echoic accuracy were gradual and somewhat variable. Further, with Subject 2 some changes were noted in echoic accuracy with respect to tongue position. As listening discrimination progressed Subject 2's echoic performances were judged to be produced with the tongue further back and higher than previously. However, the tongue position did not ever reach a point where the sound produced was close enough to the echoic stimulus to be classified as an acceptable production.

FURTHER PROCEDURES

After all listening discrimination training had been completed a procedure of using instructions and differential social reinforcement was employed with both subjects in order to determine how long it would take for subjects to learn to accurately mimic the ɯ vowel. Initially only instructions were employed. Each subject was given instructions as to what tongue and lip positions were required in order to produce the sound correctly. Further, each subject was told that the closest English approximation was the "$\overline{oo}$" sound as in boot, but produced with the lips distinctly unrounded and were given a demonstration by the experimenter. Following this, subjects attempted to mimic the ɯ stimuli. Although their productions were closer to the echoic stimulus than previously, the productions were still not within the acceptable range. The experimenter then sat with the subjects as they attempted to mimic the ɯ sound. The experimenter supplied differential social reinforcement when closer approximations were produced until each subject produced an acceptable mimicry of the ɯ stimulus. This required approximately 20 minutes for Subject 1 and 10 minutes for Subject 2.

DISCUSSION

These experiments were not designed to show that training the student as a listener was an efficient method of teaching pronunciation. The purpose of the experiment was to test the hypothesis that the ability to pronounce the difficult Vietnamese phoneme would proceed apace with the subject's skill as a listener.

With both subjects some changes were produced in their echoic accuracy as a result of certain types of listening discrimination training, although the extent and kind of these changes produced were quite limited. For both subjects the echoic errors of centralized off-glides and lip rounding at the end of the vocalizations were virtually eliminated. However, tongue position errors were not changed for one subject and were only partially improved for the second subject.

It does not seem likely that the changes produced in subjects' echoic accuracy could be accounted for simply by extended practice on the echoic task since prior to the listening discrimination training a minimum of 400 trials on the echoic task were given to each subject. The performances of both subjects essentially stabilized after 30 to 50 trials and showed no systematic changes over the rest of the 400 trials. In addition, the echoic accuracy of the subjects did not improve until they had concurrently improved on the listening discrimination tape, although, this relationship is difficult to pinpoint exactly because of the large amount of variability in the changes in echoic accuracy before stable performances were achieved.

Within this study it is not possible to say whether or not the changes in the subjects' echoic accuracy were due to the specific type of error stimuli employed on the listening discrimination tape. That is, it is not known whether or not it was necessary to have subjects make discriminations among correct ú stimuli and incorrect stimuli of the same type as the errors the subjects commonly made when they attempted to mimic correct ú's. It could be that establishing a discrimination among other types of incorrect stimuli could have produced a similar result.

In view of the limited effectiveness of the listening discrimination training and the amount of time it required (approximately 70 hours for Subject 1, and approximately 45 hours for Subject 2) it is questionable whether this type of listening discrimination procedure is currently usable as a practical technique in programmed instruction. This conclusion seems even stronger when the relatively short period of time is considered which was required to achieve an acceptable echoic response through differential social reinforcement by the experimenter. It is possible, however, that the effectiveness of the tutorial experience depended in part on the previous listening skill which the subject had previously developed.

REFERENCES

(1) Lane, H. and Schneider, B. Methods for self-shaping echoic behavior. The Modern Language Journal, XLVII, 1963, 154-160.

(2) Pimsleur, P. Discrimination training in the teaching of French pronunciation. The Modern Language Journal, XLVII, 1963, 199-203.

(3) Pimsleur, P., Mace, L., and Keislar, E. Preliminary discrimination training in the teaching of French pronunciation. Final report of the U. S. Office of Education on contract DHEW: SAE 8950. Los Angeles: University of California, 1961.

III

Some Effects of Various Reinforcement Contingencies on Performances During a Course in Programmed Vietnamese

INTRODUCTION

Techniques of programmed instruction have been used successfully for a number of years now to produce specified changes in the educational behavior of students. As it is typically employed, programming relies heavily on the use of stimulus control and fading techniques. Most often the program begins with material which the student can easily master. Gradually new stimulus material is faded in at a rate and manner in which students can perform with few errors. However, while the stimulus control of the student's performance is often closely specified, the reinforcing stimuli which maintain his performance are frequently not explicit. Further, although contingencies of reinforcement have been demonstrated to exert a powerful influence upon the behavior of humans in a variety of situations, there have been few attempts to manipulate these contingencies as students go through programmed material. That these contingencies can have important effects is shown by the following example: During a pilot study in which a child went through a reading program it was found that the extent to which the child's reading behavior was exhibited on various tasks was almost entirely a function of the specific reinforcement contingencies. The initial task of the child was that of matching-to-sample, with the sample being words presented auditorily and the choices being words presented textually. At first the child was reinforced for choosing the correct textual word. When the child achieved a perfect performance for a number of words over a number of trials on this task he was given a probe. The probe consisted of the presentation of the written words and the child was asked to read them aloud. When the reinforcement contingencies were attached to performances on the matching-to-sample task the child typically acquired an errorless performance on it, but did not exhibit any acceptable behavior during the probe. However, when reinforcement was made contingent upon probe behavior and the opportunity to engage in the probe contingent upon a perfect matching-to-sample performance both acceptable matching-to-sample performances and probe performances were developed.

The purpose of this study was to investigate this type of phenomenon in a more systematic manner with adults as they went through a programmed course in Vietnamese. The Vietnamese course consisted of 20 sections. Each section had two parts: a programmed section and a probe. The first part was a programmed series of cards in which textual and pictorial and auditory stimuli were presented to subjects. On the basis of these stimuli subjects chose among several textual alternatives. The second part of each section, the probe, was a series of stimuli again textual, pictorial, and auditory to which the subjects were to respond vocally. The probe was administered by a monitor who followed a standard protocol. The monitor was instructed only to present the various stimuli to subjects and to record their response, and not to interact with them in any other way. Thus, during the first part of each section subjects chose among textual alternatives, while during the second part they made vocal responses in Vietnamese.

Experiment 1

The first experiment which was performed was to evaluate the effects of money reinforcement presented contingent upon subjects' probe performances as against being presented upon an hourly basis for attendance. Further it was decided to use each subject as his own control by alternating blocks of sections under each procedure.

PROCEDURE

For the probe contingency payment condition the following procedures were in effect: (1) subjects could go through the programmed instruction part of each section at their own rate; (2) the programmed part of each section would be followed by the probe; (3) a lump sum of money would be paid each subject when the probe was passed. (Criteria of passage of each probe was decided on in advance by the experimenters. In general, to pass a probe the subject had to vocally exhibit at least once all of the new Vietnamese which he had previously dealt with textually in the programmed part of the section. This was a relatively strict criterion for passage, since the subject had to use the new Vietnamese material both in descriptive tasks and in response to Vietnamese questions. Any single failure of a subject to vocally emit the proper Vietnamese words or phrases was considered a failure.) (4) a subject who failed to pass the probe was required to go back to the programmed material and go through as much of it as he felt necessary in order to pass the probe, at which time the probe could be retaken.

For the hourly payment condition procedures (1) and (2) given above were in effect. In the hourly payment condition, however, money payment was made simply on the basis of amount of time a subject spent completing the programmed material and the probe. Under the hourly payment condition one additional procedure was in effect. Following each probe subjects who failed to achieve a performance equal to a pass were tutored individually until they could achieve this performance. This was felt to be necessary because of the cumulative nature of the programmed sections. In other words, the material was so constructed that a correct performance on early sections on the program material was necessary in order for a correct performance on later sections. Since subjects in the probe contingent payment condition had to pass the probe before receiving payment and thus going on to the next section, to make the two conditions equivalent at each step except for the reinforcement contingencies, subjects in the hourly condition were tutored if they did not exhibit a performance on the probe which was equivalent to a pass. The tutoring was done in a matter of fact manner and pains were taken to avoid any implication of a failure.

For both conditions subjects received their money payment immediately following each session. The lump sums which were paid under the probe contingent condition were set by the experimenter so that if a subject went through the programmed material at a normal rate and passed the probe the first time, he would receive an amount slightly in excess of what he would have received on an hourly basis. If the subject went through the programmed material at a normal rate, failed the probe, and had to return to the programmed material a second time before passing the probe, he would receive an amount less than what he would have received if he had been on the hourly basis.

The primary dependent variable of interest in this study was the proportion of passing scores on the probe the first time it was taken. However, other measures of subjects' performances, such as proportion of correct and incorrect responses and time spent per card on the programmed material, were taken.

Four subjects were used in this study. All four were students who were used during their summer vacations. Two subjects were college students, one a freshman and one a sophomore. The other two subjects were junior high students. Typically, subjects were run three times a week taking one section of the program each time, although this varied slightly because of time conflicts.

The sequencing of conditions and sections of the program is given for each subject in Table 1.

- - - - - - - - - - - - - -

Insert Table 1 about here.

- - - - - - - - - - - - - -

RESULTS

The number of probes passed for all four subjects, individually and as a group, is given in Table II.

- - - - - - - - - - - - - -

Insert Table II about here.

- - - - - - - - - - - - - -

As can be seen from the totals there was a slightly greater overall number of probes passed under the probe contingent payment condition than under the hourly payment condition. However, this difference was slight and there were no clear-cut effects of the two pay conditions on number of probes passed within each subject.

No systematic data were obtained relating the reinforcement conditions to the number of correct and incorrect responses or time spent on each card during the program material parts of each section.

DISCUSSION

A close examination of subjects' performances on each section and a re-evaluation of the reinforcement procedures employed revealed the following problem areas: (1) all sections of the program

TABLE 1

Sequence of reinforcement conditions and sections for each subject

Subjects	Reinforcement conditions hourly payment	 probe contingent payment
S1 (college soph.) S3 (jr. high student)	Sections 6-10, 16-20	Sections 1-5, 11-15
S2 (college fresh.) S4 (jr. high student)	Sections 1-5, 11-15	Sections 6-10, 16-20

- - - - - - - - - - - - - - - - - -

TABLE 2

Number of probes passed and failed for each subject under the two reinforcement conditions

		Probes passed				Probes failed			
		S1	S2	S3	S4	S1	S2	S3	S4
probe payment contingency	----	9	5	6	9	1	5	4	1
		Total: 29				Total: 11			
hourly payment	----	8	3	8	4	2	7	2	6
		Total: 23				Total: 17			

did not appear to be equally difficult. In particular, sections 6 through 10 appeared to be considerably easier than the remaining 15 sections. This unequal difficulty made it difficult to properly evaluate the effects of various reinforcement contingencies, especially considering the limited number of sections available for experimentation; (2) the dichotomization of the probe performances into either passing or failing with strict criteria for passing did not seem to be a sensitive enough measure of the effects of the reinforcement contingencies; (3) the procedure of tutoring the subjects under the hourly payment condition when they did not exhibit a probe performance equivalent to a pass may have had instructional effects which were similar to the effects of the probe contingent payment condition.

These problem areas suggested both revisions in the Vietnamese program and further experimentation. For the Vietnamese program the following changes were made: (1) sections 6 through 10 were revised so that they were approximately equal in difficulty. This was done by both combining several sections and introducing new material; (2) scoring of the probes was revised so that a subject's performance could be graded on a continuum of accuracy and completeness. In addition, several new sections were added to each probe in order to test the limits of the subject's Vietnamese repertoire.

Experiment II

The second experiment was done with the revised Vietnamese program which now consisted of 17 sections. As before, each section consisted of two parts, the section of programmed material and a probe section. In addition, the scoring system for each probe was designed such that an acceptable vocal response to each problem or situation presented on the probe received a point score. An acceptable vocal response differed from probe to probe and from problem to problem on the probe. In some cases an acceptable response could be one Vietnamese word. In other cases a sentence or two in Vietnamese might be required. However, because the subjects' Vietnamese repertoire could be predicted by the programmed material they had already completed, it was possible to specify in advance what the range of possible correct answers would be for each part of the probe.

Since the probes were composed of a number of discrete problems or situations it was then possible to assign a maximum possible score which could be obtained for each probe. In addition, the probe was arranged so that subjects did not interact with another person while they were taking the probe. A series of cards with pictures and instructions on them plus a tape recorder to present auditory stimuli provided all the stimulus material subjects required to go through the probe. Subjects' vocal responses during the probe were recorded and scored immediately afterward.

The purpose of Experiment II was to evaluate the effects of money reinforcement presented contingent upon subjects' accuracy during the programmed material and during the probe, as against money presented contingent only upon completion of the programmed material and the probe. Again, each subject used his own control by alternating blocks of sections under several reinforcement conditions.

PROCEDURE

Initially all subjects were run under conditions of payments simply for completion of both parts of each section. This was done in order to establish a rough baseline of accuracy of performance for each subject. Before starting subjects were given instructions to perform as accurately as possible on both parts of each section. When they had completed both parts of each section they were given a fixed sum of $2.50. Under these conditions the amount of time taken to complete each section varied considerably among subjects and sections, with the mean being about 65 minutes for each section and the range being approximately 40 minutes to 2 hours and 10 minutes.

During the procedure in which money was presented contingent upon subjects' accuracy there were two possible general conditions (or a combination of the two): (1) as the subject went through the program material every five correct first responses to the cards resulted in the addition of a point on a counter visible to the subject. Following the session each point was converted into money and given to the subject. Because each subject had a different baseline of accuracy on the programmed material, the worth of each point varied among subjects. However, once this amount was established for each subject it was kept constant for that subject. Typically, the worth of each point was either 5 cents or 10 cents. The worth of each point on the counter was announced to subjects in advance of the session; (2) the subjects were given a payment according to the score they had obtained on the probe. There were two different variations of this procedure which were used: (a) a fixed sum of money was set; if the subject obtained the maximum number of points obtainable, he received all the money. If the subject did not obtain the maximum number of points obtainable, he received a sum proportional to the proportion of total points obtained. This procedure was used in the cases of four subjects who had a baseline of performance on the probe where they typically obtained less than 1/2 of the total points available. Further, becuase of baseline differences in accuracy the fixed sum of money for each subject on the probe varied among subjects but remained constant for each particular subject. Typically the amount was between $3.00 and $5.00; (b) for three subjects who had a baseline of performing relatively accurately on the probe (typically obtaining in excess of 50% of the total points possible) a slightly different procedure was used. Since these subjects were already relatively accurate on the probe it seemed essential to provide a condition under which small improvements in accuracy would result in relatively large payoffs. For these subjects a point category pay basis was established such that if their accuracy continued at their normal level they would receive a nominal amount of money (approximately equal to the amount they would have received for the time spent if they had been on the simple completion payment condition). However, if subjects performed more accurately than previously the amount of pay received increased step-wise in a roughly geometric fashion to a fixed limit. Thus, proportionally small increases in accuracy resulted in relatively large increases in amount of pay received.

The subjects were seven women who had answered a newspaper advertisement requesting subjects for language experiment. All were housewives with varying amounts of previous training in foreign languages. None had any prior experience with Vietnamese.

The sequencing of reinforcement conditions for the sections of the program for each subject is given in Table III.

- - - - - - - - - - - - - -

Insert Table III about here.

- - - - - - - - - - - - - -

The primary dependent variables of interest in this study were the number of correct first responses emitted during the programmed material and the proportion of total possible points obtained on the probes.

TABLE 3

Reinforcement conditions for each subject by sections

Subject	pay for completion of each section	pay for accuracy on programmed material	pay for proportion of total points on probe	differential pay for points on probe above baseline
S1	Sections 1-3 9-12	Sections 4-8 13-17	Sections 4-8 13-17	---------
S2	Sections 1-4 9-12	Sections 5-8	Sections 5-8 13-17	---------
S3	Sections 1-3 9-13	Sections 4-8 14-17	Sections 4-8 14-17	---------
S4	Sections 1-4 9-13	Sections 5-8	-----------	Sections 5-8 14-17
S5	Sections 1-8	Sections 9-17	Sections 9-17	----------
S6	Sections 1-8	Sections 9-17	-------------	Sections 9-17
S7	Sections 1-9	----------	----------	Sections 10-17

RESULTS

The data obtained for correct first responses during the programmed instruction part of the sections yielded no consistent overall differences between the condition in which points were contingent upon accuracy and the condition in which subjects were paid merely for completing the section.

The data obtained from the probe portion of each section, however, were different under conditions of contingent pay for accuracy as against pay for completion of the section. For six of the seven subjects the mean proportion of total points obtained on the probe was higher under the contingent pay condition than under the completion pay condition. A graph of the proportion of total points obtained under each condition for all seven subjects is presented in Figures 1, 2, 3 and 4.

- - - - - - - - - - - - - -

Insert Figures 1, 2, 3 and 4 about here.

- - - - - - - - - - - - - -

DISCUSSION

The failure to obtain differences in accuracy of performance during the programmed instruction part of each section, perhaps, should not be too surprising. Prior to the present experiment this part of the Vietnamese course had been subjected to a fairly extensive program of testing and revision. Several groups of subjects

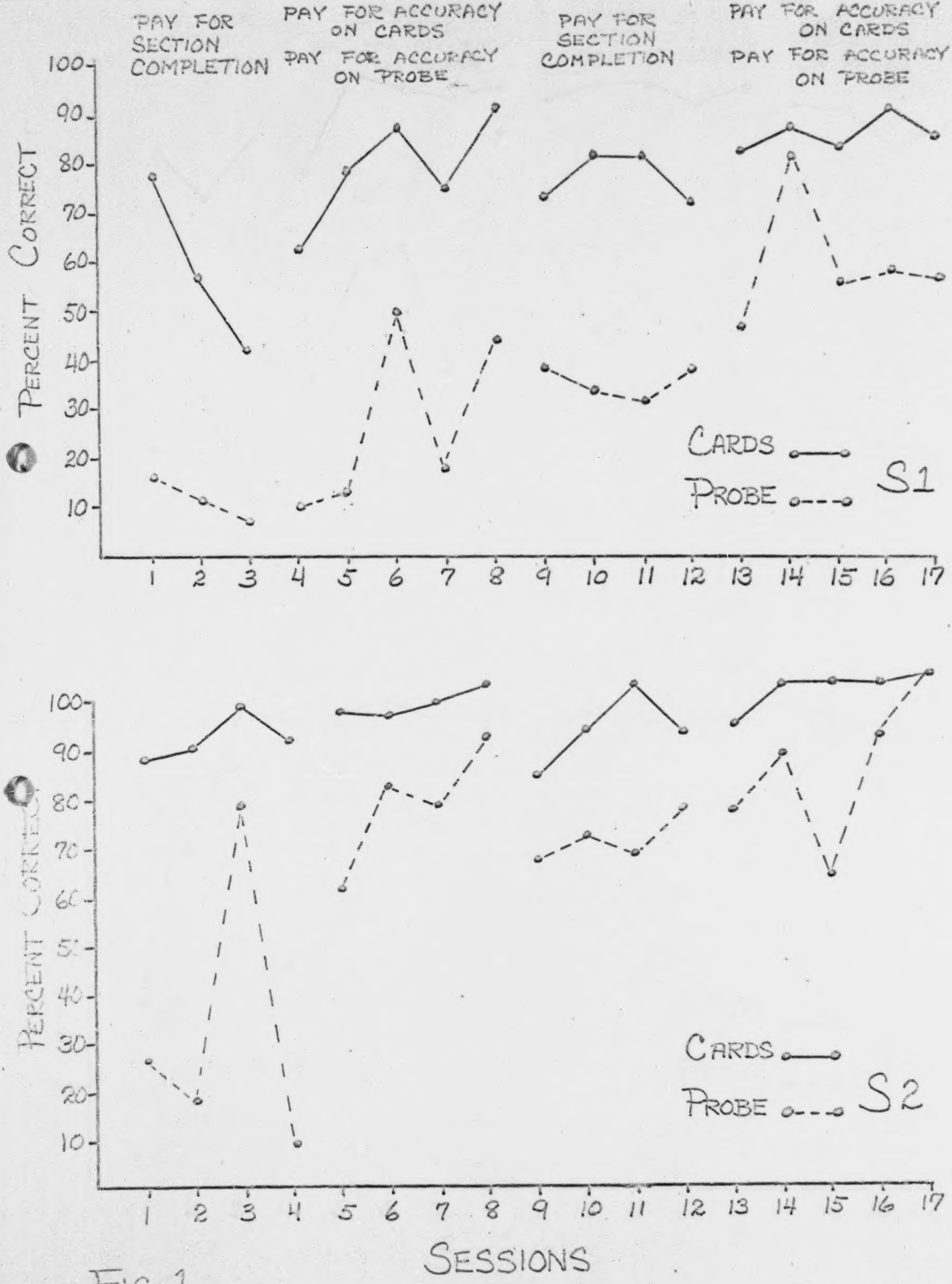

PAY FOR SECTION COMPLETION
PAY FOR ACCURACY ON CARDS
PAY FOR ACCURACY ON PROBE
PAY FOR SECTION COMPLETION
PAY FOR ACCURACY ON CARDS
PAY FOR ACCURACY ON PROBE
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
CARDS
PROBE
S1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
CARDS
PROBE
S2
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
SESSIONS

FIG. 1

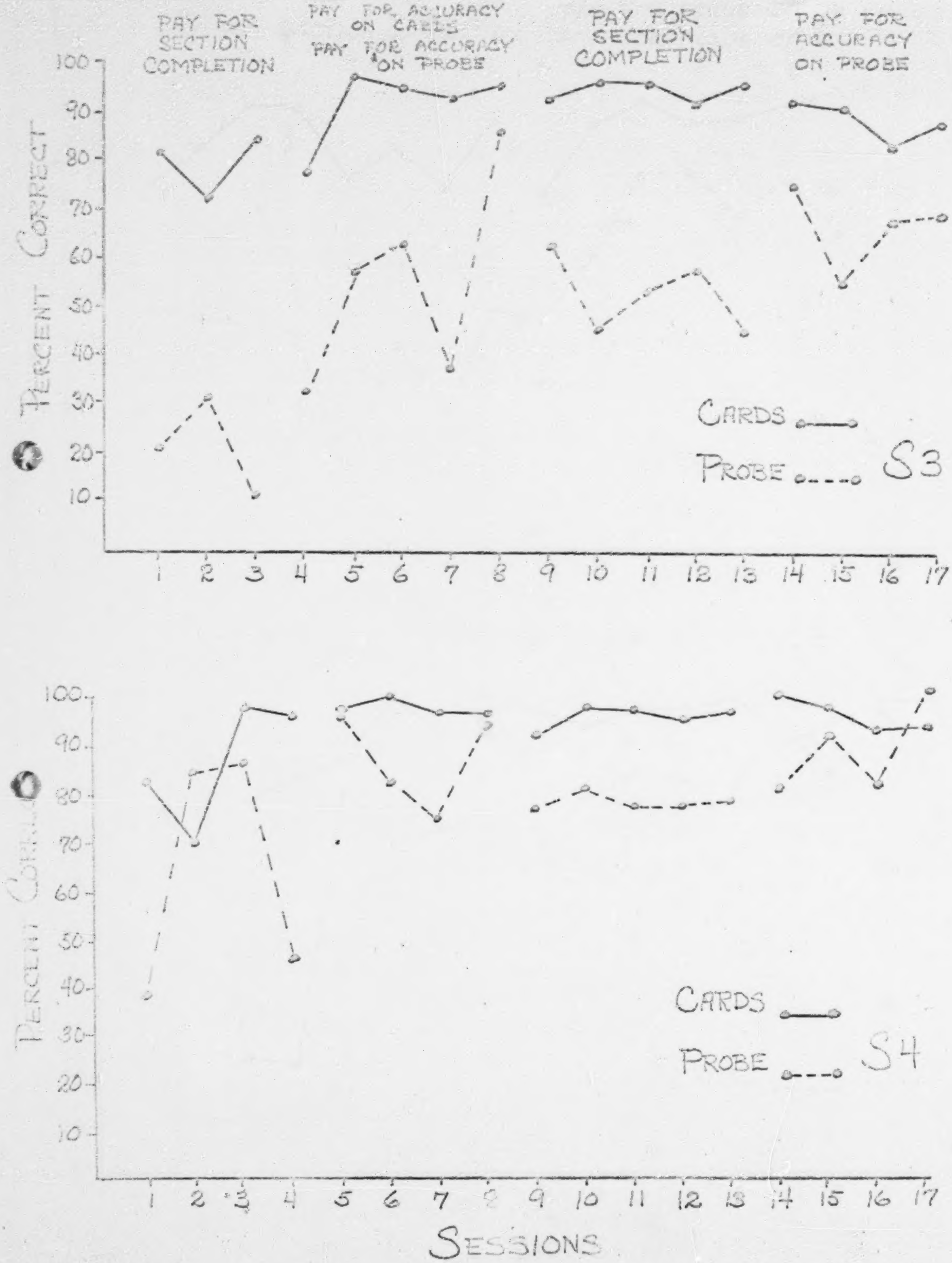

PAY FOR SECTION COMPLETION
PAY FOR ACCURACY ON CARDS
PAY FOR ACCURACY ON PROBE
PAY FOR SECTION COMPLETION
PAY FOR ACCURACY ON PROBE
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
CARDS
PROBE
S3
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
CARDS
PROBE
S4
SESSIONS

FIG. 2

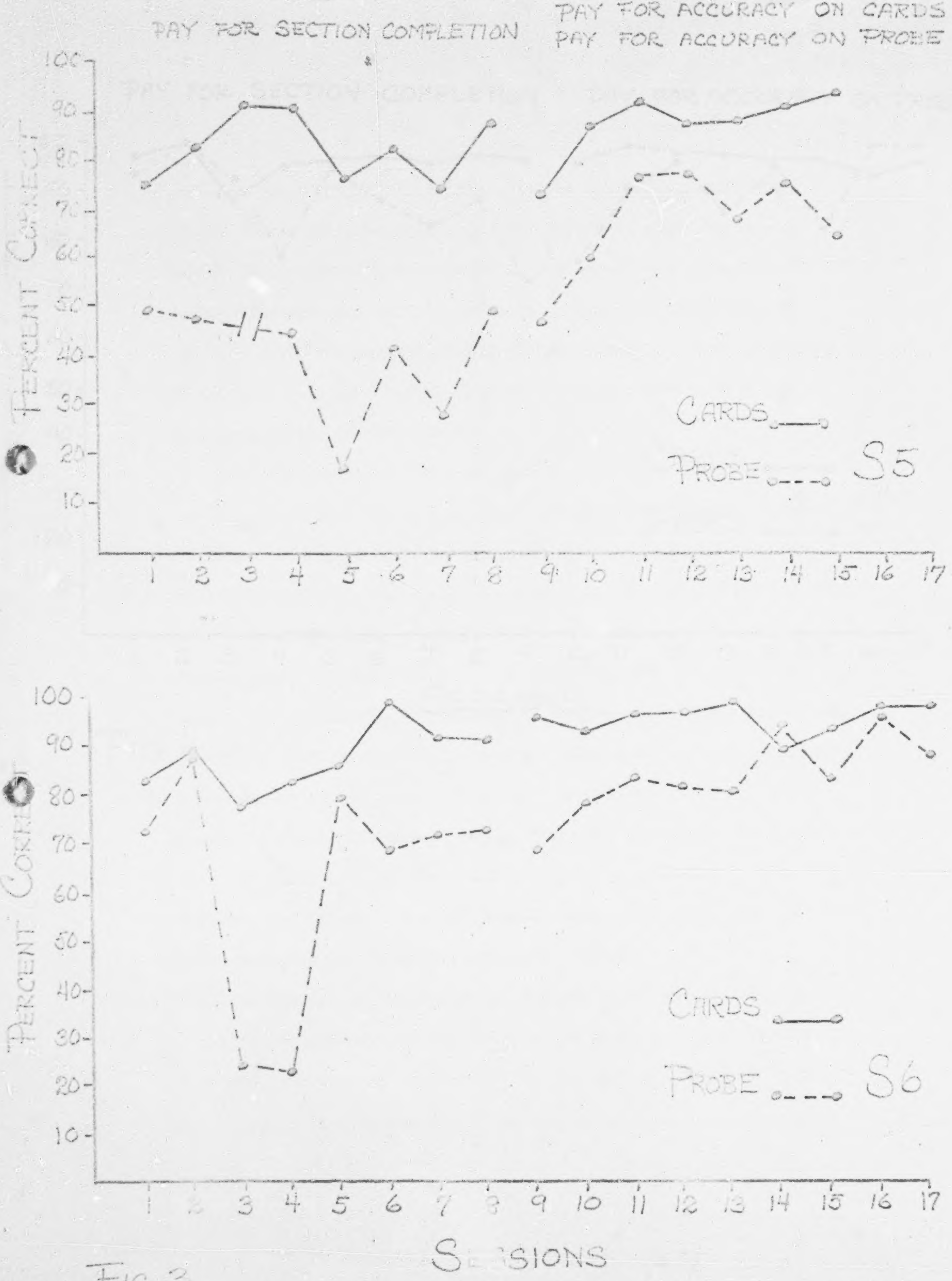

PAY FOR SECTION COMPLETION
PAY FOR ACCURACY ON CARDS
PAY FOR ACCURACY ON PROBE
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
CARDS
PROBE
S5
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
CARDS
PROBE
S6
SESSIONS

FIG. 3

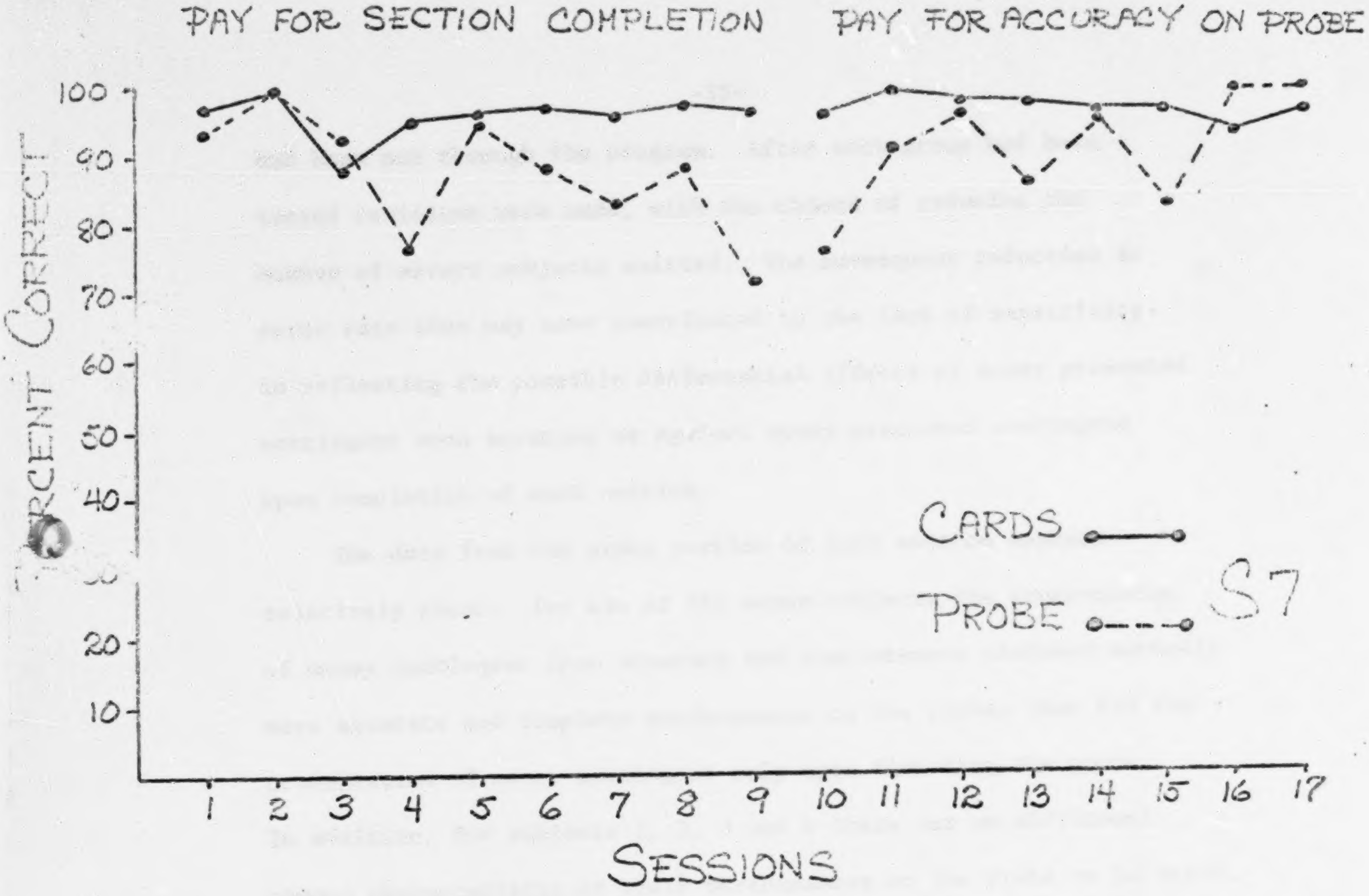

PAY FOR SECTION COMPLETION
PAY FOR ACCURACY ON PROBE
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
SESSIONS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
CARDS
PROBE
S7

FIG. 4

S 7

had been put through the program. After each group had been tested revisions were made, with the object of reducing the number of errors subjects emitted. The consequent reduction in error rate then may have contributed to the lack of sensitivity in reflecting the possible differential effects of money presented contingent upon accuracy as against money presented contingent upon completion of each section.

The data from the probe portion of each section appears relatively clear: for six of the seven subjects the presentation of money contingent upon accuracy and completeness produced markedly more accurate and complete performances on the probes than did the presentation of money contingent only upon finishing the probe. In addition, for subjects 1, 2, 3 and 4 there was an additional common characteristic of their performances on the probe to be noted. The first application of the accuracy contingent payment condition appeared to produce a marked effect. When these subjects were returned to the conditions of merely finishing the probe for payment their performances did not return to their previous rate of accuracy but remained higher. However when accuracy contingent pay was resumed accuracy on the probes rose even higher.

The results of Experiment II suggest that, for subjects with a normal English repertoire, substantial gains in vocal behavior in a second language may be obtained by application of reinforcement for engaging in this behavior. It should be noted that although money reinforcement was differential in the sense that greater vocal output and accuracy resulted in greater monetary pay, no attempt was made to "shape" subjects' vocalizations. Whatever accuracy they developed was entirely a product of their interaction with the programmed material.